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EDITORIAL NOTES

Armillaria Root Rot.

An account by Dr. Wallace of this serious disease of plantation crops appeared recently in this Journal.[1] The disease has been recorded in a large number of wild and cultivated trees; it is known to attack tea and coffee in all the East African territories; while on certain tea estates its ravages have been disastrous. We note therefore with pleasure that the recent work of Mr. R. Leach, Plant Pathologist to the Department of Agriculture, Nyasaland, has thrown new light upon the means for the prevention of the disease.[2]

All authorities are agreed that the chief source of infection is the roots of susceptible forest trees left in the ground after clearing; that the fungus invades these dying roots and thence passes to the living roots of the coffee or tea bush. Hitherto recommendations for control have concentrated on the removal of the stumps of the felled trees and of their roots; a procedure always expensive and often impossible, although often effective where it can be done. From a study of the parasitism of *Armillaria,* Mr. Leach arrived at an hypothesis that the dying roots of forest trees are a favourable

[1] Wallace, G. B., 1935.—Armillaria Root Rot in East Africa, *East African Agricultural Journal,* Vol. I, No. 3.

[2] Leach, R., 1937.—Observations on the Parasitism and Control of *Armillaria mellea, Proceedings of the Royal Society,* B, 121, No. 825.

medium for its development only if they contain large stores of starch; roots that contain no starch are invaded and destroyed by other fungi that are harmless to the growing plantation crops. If therefore it can be arranged that, when the land is cleared, the roots of susceptible species left on the soil contain no stored starch, these roots, he suggests, will be harmless to the new crop.

This condition can in practice be attained. Ringbarking a tree stem cuts the channel of transfer of the carbohydrates from the leaves where they are manufactured to the roots where they are stored as starch. When eventually the tree so treated dies, the starch reserves in its roots are found to have been largely exhausted.

The application of this method of prevention requires careful planning beforehand; ringbarking must precede felling by a sufficient time to allow of the natural death of the trees. At present, however, we do not know what this period may be for different species and for different sizes of trees; experimental evidence on this point is needed. If the susceptible species in a forest to be cleared are known, these alone need be ringed; the remainder, as Mr. Leach suggests, may be left to protect the land from denudation until the time when the whole area is finally felled. Unfortunately at present our knowledge of the susceptible and resistant species is far from complete. We hope in a future number to summarize available information on this important matter.

Mr. Leach's work thus suggests a new policy for the prevention of *Armillaria* root rot in tea plantations of the future. He is careful to point out that at present his hypothesis is unproved; although he has obtained indirect evidence in its support, a proof of its success as a practical measure must await for several years the outcome of experiments now in progress in Nyasaland. It is evidently desirable that experiments should be undertaken in other territories.

We hope to publish in a future number a full account of this work by Mr. Leach.

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DERRIS.

There have recently appeared in this Journal and elsewhere notices to the effect that a limited quantity of planting material of *Derris elliptica* will be available this year for sale from the East African Agricultural Research Station, Amani, at 5 cents per cutting or 20 cents per rooted plant, f.o.r. Muhesa. Planters requiring this material were advised to apply to the Director of Agriculture of their territory and not directly to Amani. Applications already exceed the quantity of plants that will be available, and no further ones will be considered after the end of May. It is expected that distribution will begin in June of this year.

Intending planters of *Derris* should be warned that experience in its cultivation in East Africa is extremely limited. The present offer of planting material is made, not with any idea of placing an economic crop of proved value in the hands of planters, but in order that planters so willing may carry out experimental trials in a wide range of localities. Experimental plantings have been made on the Kwamkoro Estate, near Amani, but none has yet matured.

Both cuttings and rooted plants in bamboo pots will be available. The rooted plants will be ready for planting in the field, and although freight charges may be heavy are to be preferred to cuttings, which may not survive delays in transport. We have encountered at Amani, however, no difficulty in rooting the fresh cuttings, although failures have been reported from some localities, and the

effects of long periods in transport are uncertain. The Amani method is to set the cuttings in river sand; they are kept well watered, and usually strike within eight weeks. They are then transplanted to bamboo pots for another six to eight weeks before being set in the field. Barrett[1] advises that the fresh cuttings be wrapped in a wet gunny bag for a week or more, until a good callus has formed on the end. This method has been tried at Amani, but has shown no advantage over the method described above.

A general account of the cultivation and uses of *Derris* appeared recently in this Journal.[2] Some further information can now be given. Early plantings at Kwamkoro were made at 5 ft. x 5 ft. spacing on sloping land, previously under grass or native food crops. They have been repeatedly cut back for the supply of planting material, but in spite of this treatment they appear likely to yield at about 24 months a return of roots not far below the average for Malaya (1,000 to 1,200 lb. per acre). It is evident, however, that cultivation of *Derris* on sloping land is inadvisable; difficulties of digging the roots will be emphasized, and the dangers of a large loss of soil by erosion following digging will be considerable. Further plantings at Kwamkoro will be restricted to level ground in the valley bottoms.

These early plantings were made on land that received no treatment beyond digging. Barrett,[1] however, advises as follows: —

"The writer believes that some modification of the 'layered ridge-trench' method which he worked out at the United States Agricultural Experiment Station, in Mayaguez, Puerto Rico, will be adopted. To facilitate harvesting a root crop, and to stimulate rapid growth, this method is advised.

"A trench is dug about two feet wide and about eighteen inches deep; a three-inch layer of trash (chopped grass, coarse horse dung, or even leaves or straw) is put in and covered with about four inches of earth. This is superimposed by another layer of horse dung, grass or trash, and another layer of soil. A layer of well broken-up pen manure, ashes, or some sort of slow fertilizer is spread just below the original soil surface; and the trench ridged-up about a foot above the old surface. By 'caving-off' the sides, in filling, the middle portion of the trench will be nearly three feet wide, and the flat or convex top of the ridge will be about two feet. Each linear foot of the trench will thus give about five cubic feet for the root. By planting the cuttings eighteen inches apart (diagonally across) on the trench ridge, and making the trenches six feet apart, centre to centre, the plant will have the nine square feet of ground surface which is about the average area allowed in British Malaya.

"Another method which may prove of merit is the 'nest'. Pits 24 x 24 x 20 inches, and six feet apart, centre to centre, with four cuttings per nest, allow nine square feet above ground, but only about 12½ cubic feet for the plant's root system."

Trials of intensive methods somewhat on these lines are to be instituted at Kwamkoro. It remains to be seen whether by concentrating fertility in a limited volume of soil the root system of the plant can be similarly concentrated and the digging of the roots thereby facilitated.

Nothing can be certainly said as to the optimum period of growth before the plants are dug. In Malaya this period is set at about 24 months. Odd plants of the strain now offered, grown in a variety of sites, have been analysed at Amani; the varied conditions of growth do not allow much reliance to be placed upon the results, but, although varying in age from two years to six years, all plants gave roots of a saleable quality in the present state of the market. It is likely, however, that in future the market may become

[1] O. W. Barrett, 1936: "Note on the Vegetative Propagation of Derris," *Trop. Agriculture*, 13, No. 6, p. 149.

[2] C. B. Garnett, 1936: "Derris Root," *East African Agricultural Journal*, II, No. 2, p. 111.

more selective, and the need for harvesting the roots at the stage when their Rotenone content reaches its maximum will then assume even greater importance.

The analyses already made do, however, show that the strain of *Derris elliptica* now available is capable of producing roots of high quality. Nevertheless, a policy of importing other strains is being actively prosecuted at Amani. These new strains will not be issued to the public until experiment has shown that they are indubitably superior to the strain already established.

Reviews

TREES AND SHRUBS OF KENYA COLONY, pp. xi, 201: Government Printer, Nairobi, 1936; price, Sh. 5.

CHECK-LISTS OF THE FOREST TREES AND SHRUBS OF THE BRITISH EMPIRE: No. 1, Uganda Protectorate, 1935, pp. 132; No. 2, Nyasaland Protectorate, 1936, pp. 111: Imperial Forestry Institute, Oxford; no prices.

These publications are an attempt to satisfy the need, felt primarily by foresters and agriculturists, but in some degree by all who are in any way interested in plant life, to put a name to what they see. In Africa the flora of even so small a country as Nyasaland, and the very small numbers of the book-buying population, make it impossible to publish a full flora. A start has been made with the trees and shrubs, partly perhaps as the elements of most immediate interest, but still more because for so many years they are the only section of the flora that has received the consistent attention of a government department. On the whole then, the knowledge available concerning trees and shrubs is probably less incomplete than that of other sections of the flora, and moreover the number of species involved is not quite so unmanageable. Even so, the numbers are such that economic considerations impose a choice between a full list, with the minimum of details for each, and a selection.

In meeting this demand Kenya has been a pioneer in East Africa, for Battiscombe's *Descriptive Catalogue*, of which the present volume is "a revision and amplification," was issued ten years ago. Apart from its admitted incompleteness, it is the best of the three publications now being considered. Its section on the Main Forest Types is more summary than one would have liked, but for every one of the thousand or so species in the systematic list we are given well-selected distinguishing features, the elements of its habitat preferences and ecological distribution, its uses and its names. The index of native names might have been handier for reference if they had not been divided into nine tribal groups. Not all users will know the origin of a native name they are trying to run down.

The Uganda Check-list was planned on lines which, fortunately, were realized to be imperfect by the time the next number of the series was prepared. In the former collectors' names and numbers bulk large, but for many species no other information whatever is given. For none is there any geographical distribution; and although a good many native names are scattered through the systematic list they might almost as well have been omitted because they are not indexed. The chapter on "Floristic Composition" is disappointing.

The Nyasaland publication opens with

an excellent, if occasionally provocative, description of "Some Forest Types," written with a strong ecological bias. In the systematic list all attempt at botanical description has been abandoned, and no localities are given; but we have native names admirably indexed, and indications whether each species is "common", "evergreen", "useful timber" or "used in native medicine". Exotics might well have been included in the main list and suitably indicated, instead of being kept in a separate one; especially as *Juniperus procera* has been included in both.

It will be seen that while the Uganda list tended to cater primarily for the herbarium worker, that for Nyasaland has more regard for the field man. It is to be hoped that this tendency will persist and strengthen in later numbers of the series. Not least from the field man's point of view a plea may be entered for some indication of each species' geographical distribution. It can often be used as a guide in running down some unknown plant, though to rely on such aid is admittedly unscientific.

R. E. M.

A First Guide to South African Birds, E. L. Gill: Maskew Miller, Ltd., The Bookshop, Capetown; pp. vii, 223, pl. 20 (18 in colour), text figs.; price, 8s. 6d.

One has many times heard the wish expressed in East Africa for a handy cheap book on birds with plenty of coloured illustrations. With the beginnings of biological teaching in the schools this demand has been intensified, but especially in view of the very limited local reading public it has seemed to anyone acquainted with the economics of book production utterly impossible that the two requirements of cheapness and abundance of coloured plates could be combined in a book on the birds of any part of Africa.

In South Africa the seemingly impossible has just been achieved. The Director of the South African Museum at Capetown has packed into 220 pages an account of practically all the species known to occur in the Union. The text, which is sound and well selected, is, like that of all good books on natural history, largely the results of the author's own field work. The real triumph of the book lies, however, in the plates. With an extraordinary felicity, ingenuity and economy, 400 species have been fitted into 20 plates, all coloured except those dealing with sea birds and with swifts, swallows and nightjars. These are the species that lose the least by being represented in black and white. In these plates the artistic work, which is due to both Dr. Gill and his sister, must share congratulations with the printers. The results are so excellent that the small size of the individual figures is little drawback to their value. They succeed, too, in being something more than mere diagrams: again and again the pose of the live bird is admirably caught, a matter of importance for the beginner in fieldwork. It remains to add that the figures on each plate are all drawn to the same scale, which is indicated, and that many of the species have never been figured before except in works that are expensive and inaccessible to the ordinary naturalist. The dust-cover is too charming to throw away, and is not disfigured by a blurb. Indices and references to plates are well arranged.

To the resident in East Africa the important thing about this publication is that a large proportion of the species depicted are among those we see around us here. Moreover, the genera that occur in South Africa have, with very few excep-

tions, representatives here; so that, as a general book from which children can be shown what the main types of birds look like, it serves East African purposes very well.

R. E. M.

THE EXPERIMENTAL PRODUCTION OF HAPLOIDS AND POLYPLOIDS: Imperial Bureau of Plant Genetics (for crops other than herbage), 1936; 28 pp.; 5/-.

Many plants of economic importance are polyploids, i.e. with more than two sets of homologous chromosomes. Haploids have the gametic number (n) of chromosomes instead of the zygotic number (2n). The origin of forms which have been in cultivation for a long time is sometimes obscure, but polyploid and haploid forms of many species of plants have arisen in the course of experimental work, and the possibility of inducing polyploidy is now a matter of importance. The Imperial Bureau of Plant Genetics has therefore issued a bulletin containing a rather full account of the information available on this subject. The bulletin contains a concise account of the work already done and also an extensive bibliography. The occurrence of haploid and polyploid cells in somatic tissue may be induced by a variety of external agencies, such as chemicals, X-rays, high and low temperature, decapitation, etc. From such cells there is always the possibility of the initiation of a new plant.

The union of polyploid sex cells probably accounts for most of the naturally occurring polyploid plants. Changes may be induced in the reproductive cells by the agencies indicated above. The most frequent cause of polyploidy is found in hybridization, particularly between species with different chromosome numbers.

The most important East African crop plants in which polyploidy occurs naturally or has arisen in the course of experimental work are tobacco, wheat, rice, banana, sugar cane and cotton.

There has been very little information published on the importance of polyploidy in the two principal East African export crops, coffee and sisal. Consequently they are not mentioned in this bulletin, but there is no doubt that the induction of polyploid forms from interspecific hybrids of *Coffea* species is an important line for investigation. *C. arabica* is a naturally occurring polyploid species.

The bulletin is a very valuable summary, collecting together information from many sources which are not easily accessible to the plant breeder working in the tropics.

L. R. D.

Coffee Investigational Work

Report of the Senior Coffee Officer, Kenya Colony, for 1936.

RAINFALL.

The rainfall recorded at the Scott Laboratories for the year was 40.68 inches. This is 4.48 inches in excess of the previous year's total and 3.32 inches above the average for the past eleven years. The amount recorded would appear at first glance to be adequate for the crop, but in fact the coffee produced was generally of an inferior quality and the trees in most cases showed considerable debility. An examination of the monthly rainfall gives an indication of the causes of this and confirms the statements made on many previous occasions that an average or high annual rainfall is no criterion of the suitability of a district for coffee growing. What is of more value is an evenly distributed rainfall, particularly at periods when the trees are undergoing a strain, such as when the fruit is maturing.

Monthly Rainfall—Scott Laboratories.
(Altitude, 5,800 feet.)

Month.	*Inches.*	*Average monthly rainfall over 11 years. Inches.*
January ...	5.18	2.07
February ...	6.47	1.17
March ...	4.78	5.07
April ...	6.44	8.02
May ...	2.27	6.66
June ...	3.58	1.20
July ...	0.12	0.67
August ...	0.45	1.11
September ...	0.43	1.32
October ...	4.68	2.43
November ...	3.55	4.83
December ...	2.73	2.81
Total ...	40.68	37.36

It will be noted from this table that the January and February rains were actually above the average. March and April were below the average, and the fall during the months of May, June, July, August and September may be considered almost negligible in so far as benefit to the crop is concerned, although these are most important months in the growth and maturation of the fruit. Such a maldistribution of rainfall must of necessity have a definite effect not only on the trees but on the yields and quality of the coffee produced.

MONTHLY PRUNING.

The object of this work is to enable observations to be made on the influence of pruning in relation to the amount and time of flowering and the yield of the resultant crop. The observations in this respect coincide with those of the previous year, namely, that plots pruned in October, November and December produce their main flowering in the short rains of the succeeding year. January and February plots produce a small flowering in the short rains, but the main flowering occurs in the long rains, when plots pruned in March and April also flower. May, June, July, August, and September plots produce a small flowering in the following long rains. This latter flowering is, however, entirely on old mature wood which has been allowed to remain, and little or no flowering can be expected on the younger immature wood or wood that is produced after the pruning operation, until the short rains of the following season. A heavy flowering was recorded on trees pruned during these months in late October and November, 1935. The trees in these plots had borne no crop in that particular season. The crop from this flowering matured during the year under review, but, owing to the late pruning, it is not expected that a further flowering

of any consequence will take place before the short rains of 1937.

The experiments are now sufficiently advanced in their cycle for crop weights and liquoring tests to be made. This has been carried out in the present season; but in order to obtain any significant results records must be obtained over a period of several years, and therefore they will not be published for some considerable time.

PRUNING.

Single-stem Trees.

Although most planters are now experienced in the principles of pruning single-stem trees, the careful study of the behaviour of growth and the subsequent handling operation, particularly at the time when the selection of wood for the following season's crop must be made, is somewhat neglected. Handling is a most important operation. It may not only make or mar the cropping potentialities of the bushes over a considerable period, but it may cause extra expense in subsequent pruning.

The necessity of allowing trees in a state of debility to recover fully before any pruning is attempted must again be impressed on planters.

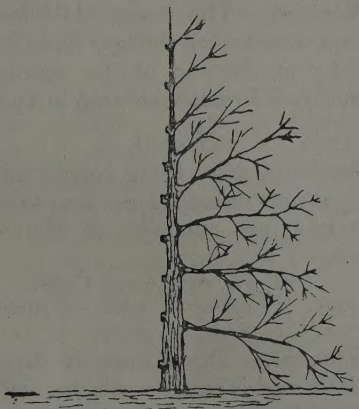
Multiple-stem Trees.

More and more planters are becoming interested in this method of growing coffee, and, while the length of the economic cycle before the establishment of new suckers may vary in different districts, the principles of pruning under this system remain the same. These principles have already been brought to the notice of planters in numerous bulletins, lectures and demonstrations, so that it is unnecessary to repeat them here, but those employing this system are again warned that such principles must be adhered to if success is to be attained. Multiple stems can be established from either seedlings or mature single-stem trees. In the former case the Agobiada method and the capping method have both proved suitable to Kenya. In the latter case, where it is proposed to establish a multiple of stems from a single-stem tree, a number of methods have been tried, such as (*a*) clean stumping, (*b*) removing all primaries from one-half of the tree, and (*c*) capping the tree back to a height of about three feet. In the last method, (*c*), the lower primaries are allowed to remain for one year to produce a small crop whilst sucker growth is encouraged from the point of the cap; after cropping the primaries are removed, and suckers encouraged at the base of the tree; these suckers eventually become the main verticals, the original main stem being cut back to the topmost one; in the interim, during a period of possibly two years, small crops are gathered from the original suckers encouraged from the cap. Both the methods (*b*) and (*c*) prevent a total loss of crop in any one year.

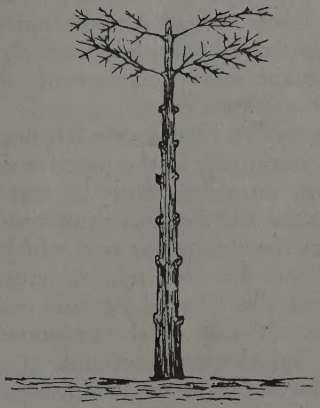
The above methods have not yet been fully proved, and, pending further observations, planters are advised to adopt a method which has proved very satisfactory at the Scott Laboratories. This consists of removing all primaries from the single stem with the exception of two to four at the apex of the tree, which are allowed to remain purely as a shade for the young suckers. When the suckers have attained a sufficient growth and elasticity the main stem is cut back to the topmost sucker. It has been noted on several occasions that this main stem has been cut back before the suckers are sufficiently established, so that severe sunscorching has been caused to the very immature wood, and the suckers have been exposed to severe extremes of temperature, resulting in "hot and cold disease". Finally, the premature removal of

A.—Clean stumping

C.—Topping tree at approximately 3 feet



B.—Removing all primaries from one side of tree



Method adopted at Scott Laboratories. Three or four primaries allowed to remain as shade to draw up suckers

the shade causes the verticals to grow too stiff, necessitating higher expenditure on the harvesting operations and leading to considerable damage to the verticals through breakages.

Particularly in the drier districts where stumping is being carried out, either for the rejuvenation of single-stem trees or for conversion of single-stem trees to the multiple-stem system, planters are once again warned to avoid leaving stubs and to treat the wounds with a dressing such as Stockholm tar, to assist healing and to prevent the ravages of termites.

The following observations have been noted on the multiple stem at the Scott Laboratories during the year. Although carrying a heavy crop, in the vicinity of one ton per acre, the bushes showed no distress, while the single stem, carrying an equivalent or lesser crop, were in a debilitated condition at the end of the season. The mottled appearance of the berries, which has been so prevalent in many areas recently, was much less accentuated on multiple-stem than on single-stem trees and ripening of the cherry was more even.

A number of trees were left unpruned at the beginning of the year for demonstration purposes, and it was most noticeable that the growth of new wood towards the apex of the tree, which is the wood for the forthcoming crop, was detrimentally affected by this omission. Further, the crop on the unpruned trees had a ragged appearance and was not so well developed as on the pruned trees. Counts were taken of a specific weight of beans, with the following result: Pruned trees, 293 beans per 50 grammes; unpruned trees, 320 beans per 50 grammes. The size of bean was also noted by the liquorer, the coffee from the unpruned trees receiving one point less for size than the pruned trees. A decided superiority was also noted in the liquor of the pruned trees. A comparative liquoring test carried out between the same variety of coffee grown on the multiple- and single-stem systems gave only a slight variation in favour of the multiple stem.

Bordeaux Spraying.

The continuation of this experiment over a period of years is giving remarkable results, particularly in regard to the retention of foliage and the consequently healthier condition of sprayed trees.

The results tabulated below should bring prominently to the notice of the planter the benefits accruing from the adoption of a regular spraying programme: —

Plot I.

Bordeaux spray, using copper sulphate and calcium carbide (1 per cent mixture) and spraying once annually, in March: —

Cwt. per Acre Clean Coffee.

1934.	1935.	1936.	*Average.*
5.78	6.3	20.9	10.99

Remarks.—The trees, while losing a certain amount of foliage, looked quite healthy at the end of the season, and should give a reasonable crop in 1937.

Plot II.

Bordeaux spray using copper sulphate and calcium carbide (1 per cent mixture), two sprayings annually, in March and June: —

Cwt. per Acre Clean Coffee.

1934.	1935.	1936.	*Average.*
5.7	5.99	23.4	11.69

Remarks.—The leafage is dark and healthy, and is considerably heavier than in Plot I. This coffee will also carry a reasonably heavy crop in 1937.

Plot III.

Bordeaux spray using copper sulphate and calcium carbide (½ per cent mixture), one spraying annually, in March: —

Cwt. per Acre Clean Coffee.

1934.	1935.	1936.	*Average.*
6.5	6.13	14.2	8.94

Remarks.—This plot is considerably less attractive than any of the other sprayed plots. Much of the foliage has fallen off, and the trees are somewhat debilitated.

Plot IV.

Bordeaux spray using copper sulphate and calcium carbide (½ per cent mixture), two sprayings annually, in March and June: —

Cwt. per Acre Clean Coffee.

1934.	1935.	1936.	*Average.*
6.48	10.61	16.6	11.22

Remarks.—In appearance this plot approaches Plot II. The trees are showing very little defoliation and the leafage is dark and healthy. It should be remembered that this plot bore the heaviest crop in the experiment during the 1935 season when it gave 10.61 cwt. per acre.

Plot V.

Burgundy mixture, using copper sulphate and Magadi soda ash (1 per cent mixture), one spraying annually, in March: —

Cwt. per Acre Clean Coffee.

1934.	1935.	1936.	*Average.*
8.4	4.7	21.0	11.33

Remarks.—In appearance there is little to choose between this and Plot I, which is 1 per cent, one spraying, using calcium carbide as the neutralizing agent.

Plot VI, Control Plot.

Cwt. per Acre Clean Coffee.

1934.	1935.	1936.	*Average.*
3.6	2.05	10.0	5.21

Remarks.—This plot towards the end of 1934 showed considerable dieback and general debility. In 1935 the trees made slow but good recovery, but practically no crop was borne, also the bearing wood was generally whippy. During the year under review a heavy crop was carried and towards the end of the year the trees were almost completely defoliated, showing no prospects of any economic yield in the forthcoming season.

The crop weights given for the various plots are of clean coffee derived from ripe cherry only. It was noticed towards the end of the harvesting season that the cherry failed to ripen and rapidly turned into *buni*. When this occurred each plot was stripped and the weight of hulled *buni* obtained in order to observe how the treatments affected the ripening ability of the bushes.

Yields of clean coffee and hulled *buni* from the various plots: —

Cwt. per Acre, 1936.

	Coffee.	*Buni.*	*Total Crop.*	*Percentage Buni.*
Plot I ...	20.9	5.2	26.1	19.9
Plot II ...	23.4	4.0	27.4	14.6
Plot III ...	14.2	10.9	25.1	43.4
Plot IV ...	16.6	2.8	19.4	14.4
Plot V ...	21.0	6.0	27.0	22.2
Control ...	10.0	12.0	22.0	54.2

Whilst it is admitted that these plots were allowed to overbear, such a practice is obligatory under certain experimental conditions in order to obtain complete results. Despite the prejudicial effect of overbearing on the trees, it is obvious that Bordeaux spraying has had a very marked effect on their health and on the percentages of clean coffee produced. Every coffee tree has an optimum bearing capacity for the conditions of climate and nutrition in which it lives, and, if it bears more heavily, debility of the tree and biennial bearing are the consequences. It would seem that spraying tends to increase the normal optimum bearing capacity, thereby giving a higher and more regular yield. While these results are fairly conclusive, it must again be pointed out that spraying alone is not the cure for all ills to which the coffee plant is subject, and unless the soil and trees are in a condition to justify the operation results may be disappointing. Spraying

should, nevertheless, be considered as a routine cultural practice.

Coffee Varieties and Local Selections.

Amfillo, an introduction from Abyssinia, which was mentioned in last year's annual report, gave a fair germination, and seedlings have been planted out in the field. No further comments can be made on the variety until observations have been made on its behaviour, cropping ability and liquoring quality.

Harar.—Harar again bore a heavy crop and the trees continued in a healthy condition during the year, although severely affected with *Hemileia vastatrix.* It seems that this variety is somewhat susceptible to the disease, but from observations at the Scott Laboratories and reports received the disease apparently has little effect in causing debilitation or heavy defoliation.

Series A.—Out of the original block planted from selections of the first generation, six trees were chosen as showing characteristics similar to those of the parent tree. Two of these six trees were, however, discarded on account of a divergence from the true bean characteristics of this type. The progeny of the four remaining trees, the third generation, are being planted out.

Blue Mountain, Padang and *Guatemala* closely resemble each other. They are of a type which is prone to overbear. This misfortune occurred during the past year of badly distributed rainfall, and so the bushes have been seriously enfeebled.

Mysore.—While this variety shows some resemblance to the aforementioned varieties, it has a more vigorous growth, although so far it cannot be considered as a really suitable coffee for the conditions which are experienced at the Scott Laboratories. It is interesting to note, however, that Mysore appears to do much better under the multiple-stem system than when grown under the single-stem system.

Columnaris.—The trees of this variety show no debilitation, due chiefly to the fact that it is a "shy bearer". This characteristic renders it an uneconomic coffee for plantation conditions, but it may be found useful for purposes of vegetative propagation.

Mulching.

As insufficient attention is being given to previous recommendations on mulching in the *drier* districts, and as observations during the year once again show most beneficial effects, planters are advised most strongly to carry out mulching as a general routine practice. It is felt that successful coffee cultivation may be achieved if the following practice is adopted.

If there is no available land for the planting of elephant grass for mulching, the acreage of coffee should be reduced and that area utilized for the planting of mulching material. Firstly, the coffee *shamba* should be deeply forked or subsoiled and an adequate mulch applied between every other row, alternating the rows mulched annually. If the mulch becomes too compact it should be turned, and eventually, when well broken down, incorporated into the soil by means of fork *jembies.* It may be of interest to quote the opinions of a planter who is growing coffee in a dry belt. He states that he considers the land planted under elephant grass for mulching purposes is equally valuable to that planted with coffee. The writer fully endorses this belief.

If a choice has to be made whether the material should be used for the preparation of organic manure in the form of compost or used for mulch, preference

should be given to the latter purpose. At the same time, every endeavour should be made to carry out both means of maintaining soil fertility. So much has been written on the subject in previous reports that it is hardly necessary to dwell on it at any great length here. The fact remains that there are thousands of acres of coffee being grown in areas of inadequate rainfall which could be made to produce remunerative crops if moisture was conserved by means of mulching, and the sooner the practice is adopted as a general practice the better for those concerned.

Shade.

Recent experiments conducted by Mr. Nutman, Plant Physiologist, Amani Research Station, have given some enlightenment on the effect of shade on coffee. This, together with the results experienced in Kenya, brings the question into greater prominence. Now that more staff is available for coffee services, a complete survey of the shade trees which are already established should be carried out, and an investigation made into the possibilities of a wider range of trees, in the hope that one or more may be found really suitable to the crop and to the various districts. Many suggestions on shade and shade trees have been made in the past, but owing to lack of staff for supervision, and to the necessity for adopting the principle of co-operative experiments in shade trials, the results have not reached expectations.

Quality of Coffee.

Coffee in Contact with Various Substances.

Early in the year, a pamphlet entitled *Factors which may Affect Liquor in Coffee* was published by Messrs. J. W. Milligan & Co., Nairobi. This pamphlet dealt with the probability of an injurious taint being imparted to the liquor due to the coffee being brought into prolonged or stationary contact with metallic substances and, further, a certain amount of evidence was brought forward to show the deleterious effect of fermenting in cement tanks, particularly new tanks where lime is present in the form of calcium carbonate. Regarding the latter, preliminary experiments were conducted in conjunction with the Chemical Section. The results of these experiments indicate that, not only does lime lengthen the time of fermentation, but also, when present in comparatively large quantities, produces a definite "unclean" taint. Confirmatory experiments were carried out on a factory scale, in which coffee was fermented in new cement tanks, old cement tanks, tanks treated with silicate of soda, and in new and old cedarwood tanks. The results were most inconclusive, and it is proposed to continue this line of work in the 1937 season.

Coffee dried on corrugated iron, wire-bottom trays, wooden trays, hessian-covered tables, and a cement barbecue also gave such slight differences in liquoring quality that no conclusions could be drawn.

Green Beans.

Another investigation undertaken was in connexion with the presence of parchment showing a distinctive greenish and, in some cases, primrose coloured tinge, the former being the more prevalent. As the seat of these colorations seemed to be the silver skin they were noticeable when the parchment was wet and somewhat transparent, practically disappearing when the parchment became dry and opaque. While it has not been possible, up to the present time, to trace the cause of the colorations, sufficient evidence has been obtained from samples collected throughout the country and liquored at

Nairobi to form the opinion that a decided taint is caused by the inclusion of such coloured beans. In practically every case the liquor from green or primrose-coloured beans was described as "filthy".

While further investigations will be pursued on factors affecting liquor, it may be of interest to state that there is some evidence to show that coffee planted on old *boma* or hut sites produces coffee which is reported on adversely by liquorers.

Coffee grown under the above-mentioned conditions may be affected in a severe or in a mild form. If affected severely it indicates that the bushes have been planted on old standing *boma* or hut sites, the result is that the bushes make very poor growth, show severe yellowing together with a mosaic-like condition of the leaves and suffer from lichen. The crop produced on these bushes is harvested and bulked with the main crop, and is thus detrimental to the liquoring quality as a whole. The fact that manures, both organic and inorganic, have failed to improve the condition of such areas, combined with the evidence that the liquoring quality is affected; planters should not hesitate to dig out bushes in these affected areas and replant with elephant grass for mulching or making compost, or alternatively to grow beans to supplement the *posho* ration.

Where the soil is mildly affected by old *boma* or hut sites, the coffee bushes, while showing less yellowing, etc., can produce big yields, but at the same time there is the danger of these bushes also producing coffee of adverse liquoring quality. The soil in these last mentioned areas can be improved over a period of years by continuous deep cultivation and heavy mulching, but until the coffee bushes show complete recovery from the symptoms previously mentioned it is suggested that the crop be harvested separately or an alternative is the cutting back of the bushes and converting them to multiple if they have already been established on the single-stem system.

Vegetative Propagation Work.

Following the appointment of a trained horticulturist, work on vegetative propagation received considerably more attention during the year than it had been possible to give it in the past. Progress was, however, considerably hampered by the uneven distribution of rainfall throughout the year.

The following are the main lines of work which are being pursued and the results obtained: —

(*a*) *Influence of Stock.* — Thirteen different rootstocks are undergoing trial, and additions will be made as material becomes available. A number of the plots carried their first crop during the year. Samples submitted for liquoring tests showed that the "stock" did not influence the quality of the crop. The most important observation made to date is that *C. eugenioides*, used as a rootstock, has a dwarfing effect on growth combined with early cropping.

A large number of indigenous and imported plants belonging to the natural order Rubiaceae have been tested as rootstocks for *C. arabica*, but all have proved themselves, so far, to be incompatible.

(*b*) *Graftings on to Seedlings in the Nursery.*—A large number of grafts have been made during the year. Most of this work has been in order to multiply clonal material from selected trees. The percentages of successes obtained by this method of grafting, although usually of a high order, have varied according to the time of the year and to the material used. September proved to be the best month of the year; whilst it was found that grafting

on to stocks of the exotic varieties of coffees proved more difficult than on to the commercial Arabica types.

(*c*) *Grafting in the Field on to Mature Stocks.*—Unsuspected difficulties were experienced with this work, but a suitable technique is being evolved, and already considerable success has been obtained. It is anticipated that good results will always be more difficult to achieve in the drier coffee-growing areas. By kind permission of the owners, the work has been carried out on Loresho Estate, Kabete, and Closeburn Estate, Kiambu, as well as at the Scott Agricultural Laboratories. A comprehensive programme has been laid down for 1937, which includes work on a number of estates representative of conditions east of the Rift Valley.

(*d*) *Propagation of Cuttings.*—Results obtained in rooting cuttings during the year were disappointing in view of the success obtained previously. A number of cuttings placed in a propagator during July, although perfectly healthy in appearance, had failed to produce roots by the end of the year. It is nevertheless highly possible that rooting will occur in due course. The slow rate of root formation is believed to be due to a new experimental rooting medium and to considerable fluctuations in temperature experienced in the propagator. A new and improved type of propagator is being constructed, in which it is believed that a constant temperature will be maintained; whilst a similar rooting medium to that which gave a high percentage of successes in earlier work will be used.

Methods of ringbarking and etiolating sucker growth whilst growing on the parent tree remains to date the only really successful method of propagating clonal clonal material on its own roots.

(*e*) *Observations on Clonal Material Propagated on its Own Roots.*—Material planted out in the field in 1932 bore a good crop during the year, and showed a vigorous habit of growth with no susceptibility to drought. The beans produced were remarkable for their evenness in size and shape.

The Economical Construction of a Cattle Dip

By R. J. MITCHELL, *Kiminini, Trans Nzoia, Kenya Colony.*

Mixed farming has been frequently discussed and strongly advocated both by agricultural officers of the Colony and stock enthusiasts amongst the settler community. Very little, however, has been done to bridge the financial difficulties of what is commonly called a "change over". In fact, the standards originally established by Government for dip construction entail an expenditure prohibitive to the average farmer. How such expenditure may be considerably reduced, without impairing either the efficiency or the durability of the dip, this article will describe. It may be well to mention that the details of cost and construction apply to a dip that is in actual use and has given every satisfaction.

The dimensions are those published by Messrs. Cooper & Nephews, South Africa, which give a 50 ft. water line. To this has been added 1,100 sq. ft. of concrete, walled-in draining pen. There are no posts and rails, since brick, iron and concrete were alone used. The total all-in cost amounts to £49. By eliminating the walled entrance crush and the dripping yard, neither of which are usual adjuncts to a dip, and by substituting thatch for iron on the roof, the cost of the dip, including the usual type of entrance and exit races, might be reduced to a total of about £36.

All bricks used were made on the farm. Stone and sand were also procured on the farm, though not readily. Cement and iron carried the "railhead" cost. Water in abundance was at hand. No so-called skilled labour was used; the work was carried out by the ordinary farm hands, one of the more intelligent doing the brick-laying and cement plastering and pointing. Supervision was, of course, necessary to bring the standard of the work up to that of a good native *fundi*.

A site was chosen adjacent to the farmyard, where shelter was obtained for storing materials. The ground had a slope of 1 in 40, and the subsoil was of suitable texture. The excavation was made with an allowance for 18 in. side and end walls, so that the entrance was towards the higher ground. The dip, when finished, being 2 ft. wide at the bottom, gradually sloping out to 4 ft. at the 5 ft. high level and retaining that width to the top, gave on completion of excavations a width of 5 ft. at the bottom, a length of 27 ft. in the deep, with an exit slope well graded to the desired length and height, leaving a bottom end width of 5 ft., increasing gradually to 7 ft. at the top end. Heavy hammers were used to consolidate the floor surface, including the exit slope.

The wall foundations were now laid, 2 ft. 8 in. apart in the deep portion. This allowed for the 2 ft. width of the dip at bottom together with 4 in. for the concrete facings on each side, care being taken to observe the necessary splay of the walls up the exit slope. These foundations were of concrete, a mixture of cement, sand, and broken stone in the proportions of 1, 3, and 6 respectively. It will be understood that all concrete work was well tamped down to ensure consolidation and the filling of voids. Only river sand was used. It was carefully washed but not screened, except for plaster work. The stone was broken to a grade ranging from an inch to that of coarse sand, and subsequently washed.

On the concrete foundations 14 in. brick walls were built, headers only showing towards the face or dip side; one row of stretchers at the back and all spaces

occurring between the wall and the bank were solidly packed with brick broken to suit. The mortar used was of the ordinary brick soil *donga* type. It was well worked and only sufficient was applied to bed the brick compactly after the manner of wood-glueing. To maintain the necessary slope of the walls, four lengths of 2 in. x 2 in. timber were stood in position, one at each corner of the deep section of the dip. Each pair was placed 2 ft. 4 in. apart, inside measurement at the bottom, and 4 ft. 4 in. apart, inside measurement, at the 5 ft. high level, the slope being equalized to both sides and the timbers so secured. The outside of these guides gave the alignment for the face of the walls for the whole length of the dip. At the entrance end the walls were built perpendicular, not sloping. To give a more compact lay to the bricks up to the water level of the dip each was gently tapped with a hammer after being pressed into position by hand. At the 5 ft. level wires were built in horizontally across the wall. These were bent over at one end to form hooks that protruded from the wall about one inch. These wires were placed about 4 ft. apart, and served to hold in position a strand of fencing wire which was passed through the hooks along both sides of the dip and round the entrance end. The loose ends were secured at the top of the exit slope with a reasonable amount of tension. The walls were now carried up to a height of about 7 ft. 8 in. from the bottom, the last 2 ft. 8 in. being built perpendicularly, headers and stretchers in the usual way, and care being taken to pack well all spaces occurring between the wall and the bank.

The brickwork having now sufficiently advanced to enable the concreting to be carried out, the cleaning of the brickwork as for pointing was next attended to, and the whole work well washed down. The resultant accumulations of mud on the floor and slope were removed and the latter again beaten firm. The concrete was now laid, a 4 in. layer of 1, 3, and 6 mixture, filling the space between the concrete foundations to an approximate level with the latter.

Reinforcing followed, and consisted of heavy gauge barbed wire (about 2½ rolls). The cross strands were placed about 1 ft. apart, their ends passing upwards between the built-in strand of fencing wire and the walls, so adjusting the reinforcing to the angle of the wall at that point. The ends were then carried over the top of the wall and stapled to poles or battens laid on a level with its outer edge. The longitudinal wires for the bottom and slope were four in number and were carried up the entrance end and secured over the wall similarly to the cross strands. Both cross and longitudinal wires were now stapled down to the concrete floor at points of contact, care being taken to observe the necessary tension for all the wires and to have the stapling done before the concrete set too hard. Wires were spaced 6 in. apart, or thirteen in all, extending along the sides and round the entrance end. Binding wire was used to fasten these to the cross strands at points of contact.

The final coat of concrete, a depth of 4 in. of 1, 2, and 4 strength, was then laid on the floor and exit slope. To form the steps up the slope, 2 in. x 2 in. scantlings were cut to the desired lengths to mould the risers; this also provided for a suitable area of tread. Shuttering for the entrance end was made in the form of a wooden frame that could be built up 2 ft. at a time as the work of concreting proceeded. Sheets of roofing iron were used for shuttering the sides. These were stood on edge and adjusted so as to give a concrete facing of 3½ in. The staying

was done by frames made to the size of the final internal measurements of the dip. A better and less expensive method of staying is, however, by laying rows of bricks across the dip at about 3½ to 4 ft. apart and placing a strip of 1 in. board between the brick and the iron. The bricks have to be built up 2 ft. at a time to accommodate each additional sheet of iron put in position as the work proceeds. Small cuttings of timber of a suitable size were used to preserve the 3½ in. spacing between the walls and the iron sheets. A suitable platform on which to prepare the concrete was made by concreting about 10 ft. square of the draining pen, the proper level and grade of which were, at this stage of the work, readily found. All the concrete for facing the dip walls was made of the 1, 3, and 4 proportions, and sufficiently liquid in consistency to find its way into the seams of the brickwork and the corrugations of the iron. This was assisted by spading and tapping the iron sheets gently with a hammer over the area that was being filled. The reinforcing wires were found to maintain a position approximating to the centre of the concrete facing without any attention being paid to this detail. To make a connexion between the interior of the dip and the sump, a piece of iron piping with a plug stopper was concreted in at a suitable level.

The concrete had set sufficiently within twenty-four hours to admit of the removal of all the shuttering without damage to the work; the iron sheets having been previously oiled to prevent the concrete adhering. To protect the work during plastering and subsequent seasoning, the iron sheets were laid over the top of the dip to form a temporary roofing. Three parts of screened sand to one of cement were used for plastering. No pudlo was used in the first coat, which amounted to filling up the iron corrugation lines and all inequalities observed in the work. This coat was quickly followed by a pudlo coat for the final plastering, the surface being well smoothed over. Three parts pudlo to one hundred parts cement, with the same sand content as for the first coat of plaster, were found to give a sufficiently waterproof finish. The pudlo coat was applied at a thickness of 3/8 in. as nearly as practicable, and a total of 10 lb. of pudlo was used. Surfaces were adequately soaked with water before plastering, and the whole work sprayed twice daily for ten days before removing the temporary roofing. The reinforcing wires were now detached from the poles or battens to which they were stapled, and built into the walls, which were carried up to their respective levels. The one on the right looking down from the entrance end was sufficiently high to deal with the splash and at the same time to adequate supervision. The wall on the left was carried sufficiently high above ground level to give a direct support for the roof for the whole length of the dip and to enclose the greater part of one side of the dripping pen. On the right side the roof was supported on pillars built 18 in. clear of the wall, to admit of easy access to that side of the dip and sufficiently high to give the necessary head room. The resulting roof span was then covered with the iron sheets used for the casing (25 in all). These covered the 50 ft. length by making a single corrugation overlap, a method that may be safely adopted for all farm buildings when new iron is used.

The entrance race was constructed of brick walls which were merely continuations of the side walls of the dip to join up with a doorway in a cattle shed 16 ft. away, serving as a collecting pen. The cattle shed wall, with the addition of the

entrance race could now be used to enclose the dripping pen on the left side of the dip, where the fall of 1 in 40 gave adequate drainage. The additional walls required to complete the enclosure of this area were built to a height of 4 ft. 6 in. and concrete capped. Bricks, being more easy to come by than stones, were used as a foundation for the concrete floor of the pen. When a firm earthen surface had been secured, the bricks were laid with all round spaces of about 1¼ in., into which the concrete was allowed to settle, especially its coarser elements, leaving the finer grouty ingredients thinly covering the whole of the brick surfaces; the whole being consolidated by well beating down. This concrete was of a strength of 1, 3, and 6, overlayed by a coat of 1 cement to 4 of unscreened sand. Roughing and draining lines were impressed by beating down with a heavy hammer a length of 3 in. x 2 in. scantling at regular intervals. By this means a draining pen with an area of 1,100 sq. ft. was well laid, using only 22 pockets of cement. All exposed walls were concrete capped, the brickwork being cement pointed and plastered where necessary.

When the dip was first filled with water a slight leakage was observed, due presumably to the floor being put down without the addition of pudlo. To remedy this a solution of cowdung and cement, three parts of the former to one of the latter, or one-third of a *debi* of cement to a full *debi* of cowdung, was creamed into twelve gallons of water and spread along the dip. No further leakage was observed.

Where suitable building stone is more cheaply procurable than brick, a corresponding reduction in costs should result by using it. By reducing the dimensions of the dip to those authorized by the Rhodesian Department of Agriculture (*vide* the *Rhodesia Agricultural Journal*, 1933, April and May), which gives a water-line of 35 ft., costs could be further lowered.

The dimensional features of a cattle dip best suited to the requirements of Kenya is a subject much debated in many parts of the Colony; and it may well be contended that what is good enough for Rhodesian conditions should serve equally well for those of Kenya. As this is a matter of more than minor importance to many farmers in the Colony, an authoritative pronouncement seems highly desirable.

The Oyster or Kweme Nut

By R. J. M. SWYNNERTON, *B.A., Dip. Agric., A.I.C.T.A., Agricultural Officer, Tanganyika Territory.*

The Oyster or Kweme nut (*Telfairea pedata*) is indigenous to Eastern Africa. It is a tall climbing plant with a slender woody stem, reaching a height of 50 to 60 feet. It is dioecious, the male and female inflorescences being borne on separate plants. The fruits or gourds have several marked ridges along their length, and attain a size of 1½ to 2 feet or more in length, and about 8 in. in thickness.

Native method of growing Kweme Nuts.

Gourds of the Kweme Nut.

When ripe the fruits burst through contraction of the ridges, throwing out the seeds together with the pulp in which they are embedded. Each fruit contains from 70 to 150 large, flat, and nearly circular seeds, each about 1½ in. in diameter, the name "oyster" nut being derived from their shape.

USES AND COMPOSITION.

The nuts are utilized for confectionery purposes, being palatable either fresh or roasted as a table nut or in the making of sweets and cakes. They may also be used for pickling or be converted into soups. An analysis of the nuts shows the fibrous husk to be 11 per cent by weight, the shell 38 per cent, and the kernel 51 per cent. The husk contains an intensely bitter substance, but this is removed chemically by the planters before sale.

The kernels contain oil to about 60 per cent of their weight, or about 35 per cent of the whole nut. The oil when extracted is of a yellowish colour with a brownish fluorescence; it is practically odourless, of low acid value and, though somewhat viscous, is liquid at room temperatures,

depositing stearine on standing. It belongs to the class of non-drying oils, and possesses a pleasant, slightly sweet taste. The fatty acids of the oil include stearic, palmitic and telfairic acids and an unidentified hydroxy-acid. The oil saponifies readily. It would be suitable both as an edible oil and for soap manufacture, while the oil cake remaining after expressing the oil from the kernels could probably be used as a stock feed and should be valuable for cows in milk.

The nuts are much valued by natives for cooking, and are in great demand by mothers, who partake of them directly after parturition, causing early contraction of the pelvis and enabling them to regain their strength rapidly so that they may resume their normal duties within a day or two. The nuts also have valuable lactogenic properties, and, among the Wasamba, failure on the part of the husband to supply a pregnant wife with Kweme nuts may be a just cause for divorce.

A young Kweme Nut plantation.

Cultivation.

Kweme nuts are widely cultivated by natives, who plant a seed about 15 feet from the foot of a suitable tree and, as it grows, lead it up into the branches of the tree, over which it eventually trails in a dense mass. Germination takes place in about a week. The climber commences bearing in the second year, and in the third year will produce from 10 to 30 gourds. In the plains it is liable to be attacked by white ants, and so may die after five or six years; but in the mountains, at elevations of over 3,000 feet, though it is slower to come into bearing and does not bear so heavily, it will continue to bear for 15 or 20 years. A good rainfall is desirable.

In the last four years several planters in the Western Usambara Mountains have taken up the cultivation of Kweme nuts, and the first plantations are now in bearing. In order to save space and lift the climber off the ground, it has been necessary to construct trellises about 6 feet high over which to train the plants. The upright posts are erected 4 to 5 yards apart and are connected with cross bars set at right angles to each other. For this purpose wattle poles have been used, but have proved expensive, since it has been necessary to purchase them at 10 cents per pole. It is estimated that the cost of clearing the land and buying, transporting and erecting the poles is about Sh. 1.500 per hectare. Wattle is now being

grown on these plantations, and when these trees are available the cost of erecting the trellises should not be much more than Sh. 600 to Sh. 700 per hectare.

The seed is grown in situ, a double row being planted every 30 yards at a spacing of 2 yards between seeds and 4 yards between double rows. The double rows of plants are then trained in opposite directions, and finally meet and interlace with those from adjacent double rows. Weeding is necessary for a year to eighteen months after planting, but once the trellises are properly covered, a dense shade is formed which allows of little weed growth. Close planting is carried out so that, when flowering commences after eighteen months, a large proportion of the male plants may be cut out. Many of the female flowers fail to set. The fruits that develop hang down below the trellises and ripen about five months after the flowering.

Yields of two to three tons per hectare are expected, though a small plantation of about a quarter of a hectare has given indications that as much as seven tons per hectare might be obtained.

Not only is the erection of trellises expensive, but this method is only suitable for the mountains, where they will not be destroyed by white ants. In order to eliminate trellises a trial is being carried out to see whether the Kweme nut will bear when trailed along the ground. The fear is that the fruits may be destroyed by insects or vermin or that they may rot when in contact with the ground, though this latter difficulty may be overcome by raising the fruits.

Preparation and Marketing.

When ripe the fruits are allowed to burst in the plantation, the seeds being picked up from under the trellises. After treatment to remove the bitter principle in the husk the seeds are laid out in the sun to dry. In wet areas, or where the fruits are liable to ripen into a rainy period, a simple, artificially heated drying shed is necessary. Care must be taken, however, to ensure that the temperature does not rise so high as to melt and decompose the oil in the seeds.

Sufficient quantities of nuts have not been available yet to test the market fully, as seed requirements for fresh plantings have been heavy. However, a consignment of ten bags of nuts sent to Europe in June, 1936, fetched £100 per ton. There has been a good inquiry from Europe, and a sample sent to the Empire Exhibition at Johannesburg has resulted in numerous inquiries, but no regular market can be established until supplies increase. It will then be necessary to evolve a cheap method of rapidly, thoroughly and cheaply decorticating the nuts.

Notes on the Forwarding of Specimens for Laboratory Examination

By the Staff of the Kenya Department of Agriculture.

Plant Disease Specimens.

Specimens should where possible be selected to show various stages of disease, and ample material should be sent, to allow of thorough microscopic examination, as well as investigation by means of artificial cultures, if such are necessary.

Where a disease is obviously confined to a particular part of a plant (e.g. leaf spot, stem canker), it may be sufficient to send only the affected portion and a certain amount of the neighbouring healthy tissue. Where, however, the symptoms are a general wilt or drying up of the tissues, the source of the trouble may be in the roots. In such instances it is desirable to send whole plants, if possible, or, at any rate, to send samples of both roots and foliage.

Full details of the conditions under which the plants are growing (locality, rainfall, altitude, soil and climatic conditions, etc.) should accompany specimens. This is especially necessary where the symptoms (e.g. yellowing of foliage, dieback of twigs, general poorness of a crop) suggest a non-parasitic cause. The past history of the land may afford useful diagnostic clues under such circumstances.

If the material is at all moist (e.g. green twigs) and has to be sent a considerable distance, it should be collected just before the departure of the mail, so as to be as short a time as possible in transit. Such material should be packed in tins or boxes which are not likely to collapse on the way, and these should be provided with ample ventilation holes. If enclosed in a paper wrapper, the holes should extend through the wrapper also, so as not to defeat the purpose of those in the inner container.

As much superficial moisture as possible should be removed from the specimens, and they should be packed in dry, crumpled newspaper or similar material, to reduce the risk of damage in transit.

Leaf specimens are best dried for a day or so under light pressure between sheets of unglazed newspaper before despatch. The paper should be changed within twenty-four hours, and possibly once or twice before the specimens are despatched. They can conveniently be sent between sheets of newspaper enclosed between two pieces of cardboard.

Roots should either be sent without soil or the roots and soil should be enclosed in paper and fastened so as to prevent escape of the latter to other parts of the contain, where it might damage the rest of the specimen.

Many kinds of specimens (e.g. cankered twigs, large pieces of diseased roots, smutted heads of small grains) require little special attention beyond reasonable care in packing.

Forwarding disease specimens in alcohol or other preserving fluid is rarely to be recommended. Apart from the risk of damage to mails in transit, the material on arrival will probably have undergone considerable change in appearance, and will be incapable of use for cultural work, since the causal organism, if present, will have been killed.

Entomological Specimens.

Almost invariably the most satisfactory method of sending insect specimens for examination is to pack them alive into a tin provided with ventilation holes, together with a little of their plant food.

A note on the insect should accompany each parcel; but it is usually more satisfactory to send the note separately, and in this case the label of the parcel should bear reference to the relevant letter. This letter should give the name of the collector, the date of collection, the exact locality of the collection and the name of the food plant, and, when possible, a description of the damage done.

It should be remembered that only in rare cases is it possible to identify an insect from its young stages, so that wherever possible adults should be sent. Sometimes, of course, it is not possible to be sure which is the adult of a particular larval stage, and in this case full-grown larvæ or if possible pupæ should be sent alive. The possibility that these may be heavily parasitized should not be forgotten, and a reasonable number should be sent so as to ensure at least some reaching the adult stage. Such collections often yield valuable records of parasites as well.

When it is not possible to send insects alive, they should usually be sent dry. Exceptions are large fleshy caterpillars, which may rot and thus become useless, and very small fragile insects. The former may be preserved in methylated spirits or formalin; the latter are best sent in a mixture of glycerine and methylated spirit.

Dry insects, except mealy bugs, should never be packed in cotton wool, which entangles their legs and antennæ and thus causes damage. They should be carefully wrapped in dry, soft paper. Butterflies and moths, when not set before despatch, should be enclosed in small, folded envelopes of soft paper.

Progress in the Study of Nutrition

A Review of Recent Publications of the Bureau of Animal Nutrition.

The growing interest in diet in relation to the health and progress of native tribes led last year to a call by the Secretary of State (then Mr. J. H. Thomas) for a comprehensive survey of the problems of human nutrition in the colonies. In response, the governments of the East African dependencies have appointed committees on the subject, which are now collecting existing information and framing programmes of investigational work. The last three Technical Communications of the Bureau of Animal Nutrition[1] bear directly on these committees' task, and their appearance could not have been better timed.

In spite of the apparent limitation of scope conveyed by its title, the Bureau has never confined its outlook strictly to questions of live stock feeding: the original research interests of its Director, Sir John Orr, lay in the field of human dietetics. There is so much that is common to man's own needs and to those of his farm animals, in the fields of nutritional physiology, the composition and biochemistry of foods, mineral balances, vitamins (now furnishing forth the alpha-

[1] Technical Communication No. 6: Composition of some African Foods and Feeding-stuffs mainly of Vegetable Origin; 32 pp., price 1/-.
Technical Communication No. 7: Wheat. Pre-eminence as a Cereal Food; Nutritive Value; Relation to Health and Disease; 31 pp., price 1/-.
Technical Communication No. 8: Nutrition Research in the British Colonial Empire; 46 pp., price 1/-.

bet book as far as P!), palatability, preparation, and storage, that the Bureau now renders its clearing-house services indifferently to workers in either branch as demand arises. Its quarterly journal, *Nutrition Abstracts and Reviews*,[2] sufficiently demonstrates this by the breadth of its scope. There might even be grounds for the reproach that we have been brought to the happy state of being well informed on progress in the science of nutrition rather through a solicitous care for the thriftiness of live stock than because of an interest in the nourishment of our own kind. There is a passage in the latest of A. G. Street's books on Wiltshire farming that illustrates this old illogical position and the modern revulsion from it: ". . . Granted, a farmer had to make his farm pay, and granted, a horse's death was much more expensive than a labourer's; but he reckoned that there must be another side to the question, that of common humanity."

Yet, however just the reproach may be in retrospect—and to insist too much upon it omits to give fair weight to the primary difficulty involved in man's very natural objection to becoming an experimental animal or to having his food habits organized by authority—leeway is being rapidly made up under medical auspices nowadays in many quarters, as witness the work on native tribal diets in Kenya to which high tribute is paid in one of the publications under notice.

Of these, No. 6, issued in November last year, brings together in tabular form all the available data on African food and feeding-stuff composition. Plant parts and plant products are listed under common names and botanical names, with vernacular names also where possible. In the columns are given the proximate constituents as determined in a standard "feeding-stuffs analysis" (water, crude protein, ether extract, fibre, ash, nitrogen-free extract), and also the mineral constituents (here the columns are often woefully blank!), the place of origin, and numbered references to a long bibliography. There is a short appendix on edible earths, salt licks, and naturally-occurring mineral supplements. Incomplete in many respects this compilation admittedly is, but it will nevertheless be a most useful guide to the practical utilization of the foodstuffs listed, as well as a pointer to the gaps that remain to be filled. Pasture grasses are not included; though a good deal of miscellaneous African data on this subject must be on record, it is rather a special field in view of the variability in the composition of a grass species from soil to soil and according to maturity, and it is no doubt being reserved for treatment in a separate publication later.

Technical Communication No. 7 concerns wheat, and is an ably written résumé of the history of the position of this grain in human diet. There are summarized accounts of its composition, protein quality and ash constituents. A general discussion of cereal consumption in relation to public health gives the present-day views of the root causes of deficiency diseases such as beriberi and pellagra. Two quotations from this section will be of interest:—

"Among wheat-eating peoples, however, beriberi does not as a rule occur, and the answer to the question why this should be so lies in the other components of the diet. If rice-eaters in the Orient were to substitute wheat flour for polished rice, without otherwise altering their diets, beriberi would still occur; but if European and North American people were to change over from wheat to polished rice it is unlikely that beriberi would occur to any great extent. This is because, broadly speaking, Western civilizations have a safeguard against vitamin B deficiency in the

[2] Available from the Amani Library.

other components of their diets, namely milk, eggs, fresh vegetables and fruit. This protective advantage must be non-existent where beriberi is endemic, otherwise the disease would not occur."

"There is no nutritional reason for advocating increased consumption of wheat among the advanced peoples of European and North American countries, who already consume large quantities. Indeed there is much evidence pointing to the desirability of diminished consumption of wheat in favour of increased consumption of protective foods, such as milk, butter and eggs. Is it not precisely in this very consideration that the answer to the question lies? As an outlet for surplus wheat, it would be infinitely more in the interests of public health to press for its increased use as a feed for stock, thus converting it into the nutritionally superior commodities, milk, butter, eggs and meat, than to encourage its increased consumption in the form of wheaten bread.

"In countries where maize and rice are the staples the case is different. . . . Rice contains less protein than other cereals, and even if protective foods are used it is difficult to believe that the use of so much rice can be anything other than detrimental to health. To alter the traditional dietary habits of rice and maize-eating peoples in the direction of a greater use of wheat is, however, a matter of great complexity. Such a change can be accomplished only very gradually, and is to a considerable degree dependent on raised standards of living following improvement in economic conditions."

Finally, Technical Communication No. 8 is a series of chapters summarizing, under geographical heads, the progress that is being made in nutritional research in the various countries of the Colonial Empire. Outstanding is the section on Kenya: "In no other part of the British Colonial Empire has more nutritional research been done than in Kenya Colony." Here we have an excellent though somewhat brief account of the findings. Tanganyika has so far no systematic work to its credit, though there have been a few isolated investigations, and nutritional factors have been taken into account in other medical work, as on morbidity and mortality from malaria. Important work done in Uganda relates to vitamin deficiencies and the influence of diet on incidence of tropical ulcer; Zanzibar has studied diets by social classes and compared the food of rural and town populations. It is, of course, only too plain from these accounts that unsophisticated native diets are often, quite apart from energy deficiencies under famine or semi-famine conditions, incomplete in essential "defensive" or "accessory" constituents; and also that sophistication does not always lead to improvements in desirable directions. A vast field of inquiry and constructive proposal lies before the Nutrition Committees that are now sitting. It is to be hoped that the resources put at their disposal when plans come to be put into action will be commensurate with the magnitude of the task.

G. M.

The Oil Palm (*Elaeis guineensis* Jacq) in the Kigoma District

By T. C. CAIRNS, *B.Sc., Agricultural Officer, Department of Agriculture, Tanganyika Territory.*

INTRODUCTION.

The oil palm has been cultivated in the Kigoma district, particularly in the vicinity of Ujiji, for a period exceeding the memory of the oldest inhabitants. Tradition has it that seed was originally introduced during a period of tribal warfare waged between the then Sultan of Ujiji and a Sultan from the Congo who had married his daughter. The girl, alleging that she had been ill-treated, returned to her father, but was followed by her husband, who entrenched himself to the north of Ujiji. He planted oil palms which he said would remain till he subdued the country, which he would make his own, and be a permanent record of his greatness. Although apparently defeated, he left a record behind him. Apart from this traditional explanation of the presence of oil palms, and although wild or semi-wild palms are to be seen in many places, it would appear to be doubtful whether the plant is indigenous to the countryside. The wild palms were probably planted by birds, or are growing in areas formerly inhabited, as the population of Ujiji has been steadily dwindling since the abolition of the slave trade. It is also highly probable that seeds have been introduced from the Congo by natives and others from time to time.

SOILS.

The palms are found growing on a variety of soils, including those derived from the Karroo system of sandstone rocks and shales, and from the quartzites and schists of the Muva-Ankolean system, but the palms flourish best on the well-drained alluvial soils of the river valleys. Palms are found growing on fairly steep slopes, but usually in proximity to houses which afford protection from erosion, and where the soil is generally more fertile, benefiting from the refuse thrown out.

TYPES.

Two main types are to be found, and these approximate to the West Coast types. In the first the pericarp is large, with a shell 3 to 5 mm. in thickness, and a kernel of small dimensions. The fruit before ripening is a dark purple, almost black, colour, but when ripe is red, only the tips of the fruits retaining a blackish tint. This variety is the one most commonly cultivated, and is known locally as *hote*. It would appear to belong to the type known as *deli* (*E. guineensis* var. *dura*). The other type has a thin fibrous pericarp which before ripening is dark green in colour. The shell is 5 to 6 mm. in thickness and the kernel is about twice the size of that described above. On ripening, the fruits are bright orange in colour. This type would appear to be that described as "Congo", and is known locally as *vuma*. Another type called *timbe*, which appears to belong to the "Congo" group and on ripening is yellow with a red tip, is also found in small numbers. It is probable that other types also occur.

METHODS OF PROPAGATION.

Seedlings are usually secured from seeds which have fallen from the taller trees and germinated where they fell. Occasionally small patches of seedlings are raised in the compounds of the houses. The seedlings when about one year old are planted at the commencement of the

rains in shallow pits, usually close to the houses, and are watered as necessary. Subsequently, they receive but little attention, but as the plant is very hardy it seems to survive under quite severe conditions.

Ripening of the Fruit and Yield.

The plants commence to bear in from three to six years after planting out, and continue to produce fruits for many years. In the better soils the plants bear earlier and more heavily. Although no fruiting bunches have been actually weighed, some weighing up to forty pounds and forming a one-man load have been seen. *Hote* is the best yielder, and up to ten bunches of fruit have been seen on one palm at the same time. Annual production at its best probably does not exceed six bunches. The fruits ripen all the year round, but September is said to be the best month, and most ripe bunches are harvested at that time.

Pruning.

As the palms increase in height the lower or dead leaves are removed by hacking them off with an axe or *panga*, leaving a peg about one foot in length. Eventually these pegs disappear, and ladders of bamboo are tied to the trees when the fruit is collected.

Preparation of the Oil.

The usual method of preparation is that known in Nigeria as the "soft oil" process. The fruits on ripening are boiled with water in a clay or other vessel. The contents are then poured into a wooden mortar and pounded up. The pounded mass, together with the water, is poured into a wooden trough; the oil which rises to the surface is carefully skimmed off; the sludge sinks to the bottom and is squeezed by hand to further express the oil. In some instances the contents of the trough are again boiled and a further supply of oil is obtained. The oil (*mawese*), which is of a bright orange or red colour, is then gently heated to drive off excess moisture, and is ready for use. The kernels also produce oil (*mise*), which is white in colour. They are taken from the shells, which are broken laboriously by hand on a stone and treated in a similar manner to the pericarp, the work being done by women.

Uses of the Oil Palm.

Apart from the use of the oil for culinary purposes, the palm has many other properties. Streets in Ujiji are lined with palms; the dead leaves provide fuel, or can be used for fencing compounds. Unfortunately, there is one use of the palm which is all too common—the manufacture of palm wine or *malovu*. To obtain *malovu* the trees are felled close to the ground and the leafy top hacked off. Clay pots are then tied to both ends and covered with fibre to exclude dirt and insects, and the sap collected. The oil from the pericarp and kernels is also used locally in soapmaking and as a cheap lubricant.

Extent of Cultivation.

The oil palms is found growing in suitable areas from the Kaseke River Valley to Kasanga on the shore of Lake Tanganyika. A large grove of wild palms in an almost pure stand is situated near the mouth of the Malagarassi River, and is said to have been communally planted many years ago. Many people own a few trees planted outside their houses or in their *shambas*. The planting of palms under plantation conditions is practically unknown, but small areas are cultivated by Indians or Arabs. A few years ago the number of palms in cultivation is said to have been much greater, and individuals

Making Palm Oil in Kigoma District.

who owned up to one hundred trees were by no means uncommon. Three reasons for the decline in cultivation are as follows: The value of the oil has fallen since the period of depression of world commodities. The priests, or *wateko,* who control the valley lands are accused of claiming as their property all palms in the valley areas on the death of the owner. If his heirs wish to own the palms they must buy them back. They are usually felled. The number of palms in cultivation has declined, but the demand for *malovu* still exists, and many of the trees planted some twenty years ago have been felled for this purpose and not replanted. The sale value of the wine may reach a high figure. It is stated that during the Belgian occupation the industry was greatly stimulated by the presence of native troops from the Congo, who were accustomed to palm oil, but the industry since those days has shown a steady decline. A few trees are found in Kasulu and Uvinza, but above an altitude of 3,000 feet the fruits do not appear to ripen.

Pests and Diseases.

The palms generally appear to be healthy and to have but few pests or diseases. Flying locusts did some damage, but the palms soon recovered.

Imports of Oil through Kigoma.

The following are the figures since the year 1930:—

Year.	*Quantity. Cwt.*
1930	1,470.90
1931	1,182.62
1932	378.45
1933	64.53
1934	73.92
1935	393.00

During the present year the imports have risen very considerably, reaching 904.70 cwt., valued at Sh. 12,665/95. This is stated to be due to the fact that formerly large quantities were smuggled in over the border, a practice which has practically disappeared. A duty of Sh. 2/50 per 100 lb., or 20 per cent of the value fixed by the Comptroller of Customs, is levied on all imported oil. The oil not consumed locally finds its way to the soap works of Mwanza, Tabora, and Dar es Salaam.

The Re-development of the Industry.

It is the desire to re-establish this industry on a sound basis, and it would appear that if the trouble described with regard to the ownership of trees could be solved, then the re-planting of palms on a large scale would take place. The Director of Medical Services is anxious to obtain supplies of this oil, which contains Vitamin A, for use in the prisons of the Territory. The total local production could easily be disposed of in the country, and a useful cash crop developed. The free fatty acid content, which increases with keeping, must, however, be below 5 per cent if the oil is to be used for cooking. The export of palm kernels, which went on in a small way, could be revived, or the oil extracted locally. Unfortunately, none of the local merchants are interested or willing to organize the collection of fresh fruit and undertake the extraction of oil on a comparatively large scale. Most of the oil produced locally is consumed locally. Propaganda to increase planting has been commenced, and a small plantation is being started at the prison.

Some Aspects of Groundnut Production

By T. R. HAYES, *M.Sc. (Tech.), A.I.C.T.A., Acting Senior Agricultural Officer, Uganda.*

The groundnut has a remarkable range of soil and climatic conditions under which it will grow. Its cultivation extends from the tropics to the almost temperate regions of Italy, Spain, and South Russia. It will tolerate quite a large range of soil conditions also. In Burma, while the yield is better on the sandy loams of the uplands, it will grow on heavy soils, and even stiff black clay is only considered unsuitable on account of the cost of harvesting, and is used for groundnuts where sandy soils are not available.

In West Africa, where the bulk of African groundnuts are produced, a typical good groundnut soil is a light, sandy, well-drained loam, not too rich in organic matter. The rainfall is about 40 inches, but this is concentrated in six months of the year. Under these conditions crops of over a ton per acre of unshelled seed can be obtained. In the Congo, while a friable sandy loam is preferred, the crop does well on loamy or clay soils, even if they are compact, provided they are well tilled to a depth of 4½ inches but not deeper.

In Senegal, the crop is often grown on the poorer soils, and in many parts the land is relegated to groundnuts after it has served to grow the more exacting food crops. If the land is very rich to begin with, this is good policy, as the organic matter is used by crops such as maize, which demand it, and it is not excessive by the time groundnuts come to be planted. This practice can be carried too far, and the use of generally infertile and worn-out soils is naturally reflected in the yield, as is also the practice of continuous cropping of groundnuts without rotation. The comparative tolerance of the crop to such conditions has resulted in a lack of attention to soil conservation in some of the largest groundnut producing centres of the world, and has caused general and serious reductions in yield.

ROTATIONS.

The groundnut fits easily into a large variety of rotations, and being leguminous it is a very useful subject to include from the soil point of view. In the U.S.A. a recommended three-course rotation consists of maize and clover, English potatoes and cowpeas, groundnuts and rye; after seven years of this rotation the yield of groundnuts was three times as great as from land continuously cropped with them.

In Senegal and the Gambia the chief alternatives are sorghum and millet. These are sometimes alternated with groundnuts, but as the latter is the only cash crop it necessarily occupies too large a part of the rotation, and often groundnuts are repeated each year until the yield becomes unremunerative.

In Egypt groundnuts follow bersim, beans, barley or lupins, and in some parts the crop is used as a change from cotton; usually a winter fallow immediately precedes the crop. In Uganda also, fallow land is usually chosen for the crop, and the new land is not found to be too rich; the groundnuts are then followed by a cereal-cotton rotation. In Rhodesia the largest yields are obtained with rotation, a favoured system of cropping on red soils being velvet beans, followed by two crops of maize and then groundnuts. In the Congo the crop enters into rotation with maize and simsim.

In India groundnuts are rotated with a large variety of garden crops, but cereals and cotton are the most important alternatives. In the Central Provinces experiments extending for seven years have shown that the groundnut is the most suitable crop for rotation with cotton. This system resulted in an average yield of 755 lb. of cotton per acre, compared with 471 lb. of cotton in a cotton-cereal rotation, and 321 lb. with continuous cotton. The beneficial effect of groundnuts on the alternative crop has also been demonstrated in Mysore, where higher yields of eleusine (*wimbi*) were obtained in rotation with groundnuts than with *Dolichos lablab* or continuous eleusine.

Intercropping.

Among peasant cultivators in Africa, groundnuts are often interplanted with maize, guinea corn, millets, cassava, cotton, etc., though in the large groundnut-producing areas the proportion of groundnuts is so large that the majority is planted in pure stands. In Madras it is seldom grown as a pure crop, but generally interplanted between cereals. Another method there is to dibble groundnuts in after the cereal has been weeded and continue the cultivation of the groundnuts after the cereal has been harvested. A similar practice is carried out in China, the cereal in this case being wheat or barley.

In Alabama one-third of the extensive maize acreage is interplanted with groundnuts, which are used for fattening pigs. J. D. Pope found that the yield of maize per plant acre was greater in interplanted maize than in pure stands, and the yield of groundnuts was very little affected. In Georgia also a runner variety is extensively interplanted with maize when the latter has received its final weeding. The runner variety is more expensive to harvest than the bunch, but this expense is completely cut out by the simple expedient of turning the pigs on to the field, and they do their own harvesting. Pigs fatten quickly on this diet, but care has to be used or their fat becomes too soft. The usual practice is to stop the groundnut ration about a month before killing, and feed on starches to harden the fat.

Experiments in Nigeria showed that by interplanting groundnuts with millet the total value of the produce was greater than that obtained from groundnuts alone, and in another experiment it was found that the cost of production of the cereal was halved.

Intercropping with Cotton.

While the ideal areas of cotton and groundnuts do not always coincide, there is considerable overlapping, and there are many areas where the two crops grow more or less equally well side by side. Where one gives a somewhat better return for labour expended, that crop is developed to the neglect of the other. The famous disasters that have happened in the past to "one-crop countries" act as a strong warning to the rest to have their eggs in different baskets. The secondary crops, however, do not give such a good return as the main crop, and usually the former is neglected in favour of a better immediate profit, instead of regarding diversification of crops as an insurance policy against future disasters. In this connexion it is worth quoting a case in the United States. The one crop was cotton, and the ravages of the Mexican boll weevil caused such a reduction in yield that farmers were forced to change over in part to groundnuts and mixed farming. The solid prosperity which followed this diversification was of such advantage to the broad economic well-being of the farming community that a

statue of a boll weevil was erected in honour of the pest that forced them to change over.

It follows that in many areas where cotton is the main crop, groundnuts are a potentially valuable subject for interplanting. While the latter may not pay as well as cotton, if a saving in the cost of preparation of land and weeding can be achieved by interplanting with the secondary crop, the latter may give as good a return for labour expended as the major crop. Groundnuts could then be developed into a second staple cash crop.

Cotton is interplanted to some extent with groundnuts in Georgia, and in Nigeria experiments have shown that the yield of cotton was unaffected, or else the reduction was so little that interplanting remained a paying proposition, taking into account the labour expended. The groundnuts were sown before the cotton, but they remained for some weeks after the latter was sown.

In Uganda interplanting experiments with cotton and groundnuts have been carried on for several years, in Elephant grass country (Bukalasa, Buganda) and in the short grass areas (Teso and Lango).

A summary of the Bukalasa trials is as follows:—

	Gross Cash Return, Sh. per Acre.		
Treatment.	1933.	1934.	1935.
Cotton alone ...	91/-	99/65	95/10
Cotton and 1 row groundnuts ...	99/-	157/07	110/10
Cotton and 2 rows groundnuts ...	—	166/11	115/62

In 1934 the yield of interplanted cotton was actually increased; there is usually a slight depression in the yield of cotton, but this is more than balanced by the return from groundnuts.

In the short grass country the summary of results is as follows:—

	Gross Cash Return, Sh. per Acre.		
Treatment.	1933.	1934.	1935.
Cotton alone ...	37/26	61/56	37/14
Cotton and 1 row groundnuts ...	47/16	70/47	44/23
Cotton and 2 rows groundnuts ...	44/12	73/12	—

The 1933 and 1934 experiments were carried out in Lango, and while the treatment with two rows of groundnuts was the best on the average in 1934, there are indications from some of the individual experiments that one row is less likely to have a depressing effect on the cotton yield. Unfortunately, one row of groundnuts is more liable to be affected by rosette disease, which is largely influenced by spacing. There is also evidence that the time of planting of each crop has an important bearing on the success of the trial. Further details would have to be worked out, and difficulties overcome, before the practice could be made general, but the results obtained to date indicate that this is a very promising field for further research.

Groundnuts Between Permanent Crops.

Another sphere of usefulness for the groundnut is found in the intercropping of permanent crops during their establishment. It is interplanted with citrus in Portuguese East Africa owing to its manurial effect on the main crop. In Uganda it often occupies the space between young plantains during their first season, and, apart from the economy in weeding, the disturbance of the soil when lifting is equivalent to a fairly deep digging, which is of considerable benefit to the plantains. It has been recommended in Kenya as a catch-crop between young coco-nuts, but in Ceylon groundnuts are not considered suitable for this purpose, as they attract rats, which then go for the coco-nuts.

Groundnuts then are a useful crop for interplanting among young permanent

crops, provided they are not grown near enough to the trees to injure the roots when lifting. The cost of weeding can be charged against the groundnuts instead of the plantation, an excellent cover is provided during the period of heavy rains, thus reducing erosion, and if the tops are not removed from the *shamba* the soil is improved rather than exhausted. This cropping can only be carried out while shading is not too thick. A moderate amount of shade is of little consequence, but heavy shade causes undue development of haulm at the expense of nuts.

Water Relations.

A limiting factor to interplanting is moisture. If this falls so low that competition for water between the two crops becomes acute, both crops suffer and the practice becomes uneconomic. The groundnut flourishes with a rainfall during its growth of 25 to 45 inches of rain, though generally yield begins to be affected as these limits are approached. A case has been reported from Mysore, however, of groundnuts coming to maturity with only ten inches of rain, and there the best yield in ten years (2,000 lb. per acre) was obtained with only 15 inches of rain. In the Central Provinces, in a severe season with only 23 inches, an average of 1,100 lb. per acre was obtained.

The distribution is much more important than the gross rainfall. Light rains will suffice for the first month or more; during the following six weeks ample rainfall is desirable, and given this the crop makes rapid growth, completely covering the ground. The critical period commences just before the main wave of flowering and continues for a short time during the setting of the pods. Badamy found in India that this period commenced about 45 days after sowing and continued for four weeks. The incidence of the period will depend on the variety grown, and in the case of bunch will be about a fortnight earlier than with runner. If good rains fall during this period a good crop is practically assured. After this, given well-distributed light showers, there is nothing to fear, as the tap root has now penetrated to lower levels and the moisture reserves in the subsoil can be drawn on; a complete break in the rains of two or three weeks will, however, check the development of the kernels, and will result in a certain percentage of shrivelled nuts.

Local experience of weather will influence the sowing date, so that the critical period will fall when heavy rains are most likely to occur. When planning interplanting trials, the date of planting of the cotton or other crop should be arranged so that the second crop is not making large demands for water during the month that the groundnuts require it.

The Marketing of Coffee

By T. S. JERVIS, *Department of Agriculture, Tanganyika Territory.*

"It is estimated that the current 1936-37 Brazilian crop will be some 7,000,000 bags in excess of shipments and that the 1937-38 crop may show a surplus of 9,000,000, making with last year's surplus an excess of 20,000,000 bags in three years.

"Brazil's problem of over-production is not yet solved in spite of the incineration of 38,000,000 bags of coffee in recent years."—London Correspondent of the *East African Standard;* London, 29th December, 1936.

By her interference with the law of supply and demand Brazil has so flushed production elsewhere that she is no longer in a position to dictate, and, with the present low level of coffee prices, is finding it increasingly difficult to stem the tide of internal discontent which threatens to break down the valorization dam, maintained since 1924 at a cost of £60,000,000, and to flood a saturated market with these surplus stocks.

Though it is improbable that any such dire calamity will overtake the industry, these stocks have got to be liquidated; and though the recent Pan-American currency arrangements and the improved trade conditions resulting in a general rise in commodity prices have caused the coffee horizon to appear more favourable, it would be unwise to consider this improvement anything but temporary in view of the economic stress under which Brazil labours to-day. Instead of any lasting improvement in the general price level of coffee, we are faced with a further fall, which must eventuate with even a gradual off-loading of Brazilian stocks, in view of the yearly increase from the ever-expanding acreages coming into bearing in other countries.

Brazil continues to catch the high lights in the coffee picture and engages the mental eye to the exclusion of other producing areas. Planters are being lulled to a sense of false security in the knowledge that the banks carrying the Brazilian baby cannot afford to let it fall, and they optimistically hope that, given time, it will come to rest in the cradle of stabilized coffee conditions.

The Pan-American Coffee Conference which took place at Bogota (Colombia) last October will tend to bolster up these hopes, and it is as well to quote here the following significant paragraph from the *Wall Street Journal* of the 2nd November, 1936:—

"Any additional encouragement given Brazil's competitors may react against herself. It is possible that the Bogota idea may ultimately turn out to be another milestone on the road to Golgotha of Brazil."

The Kenya Coffee Board Bulletin for December, 1936, contains the following caution:—

"It is obvious that the more successful the present valorization plan may be at the outset, the greater will be the danger of its ultimate collapse due to the incentive that it must afford to coffee planting all the world over. In a word, while the short-term outlook is better than it has been for a long while, the long-term outlook has dangerous possibilities."

And meanwhile what of the development in countries outside this South American group where production is already galloping forward? What of the potential yield from the vast acreages planted, and to be planted, under the parental guidance of the Governments of Holland, France, Belgium, Italy, and Great Britain — native grown coffee which is being standardized in quality and marketed in bulk?

The capitalist coffee planter is very apt to regard this native-grown coffee as of no consideration as a possible competitor,

disregarding the fact that there is no material difference in the two commodities, and that, given the right environment and equal facilities for development, the one is capable of reaching as high a standard of perfection as the other, with inevitable competition to meet the demand. There is a mistaken idea of superiority in regard to plantation coffees as compared with bulked coffees, which makes the position of the former precarious. Other considerations being equal, a better prepared article will undoubtedly command a better price, but this difference in price is in inverse ratio to the amount of care given to the inferior coffee, and decreases as the culture and preparation of the latter improves.

Certain coffees are in a class by themselves, and as fancy parcels will command fancy prices; I do not propose to deal with these. My object is to show that, excluding the "A"s and "PB" from plantation coffee, the average individual parcel commands very little more than the bulk coffees, and its position must therefore be considered in relation to the latter and not as a thing apart. The "A"s and "PB" in any parcel seldom exceed 30 per cent of the whole, so that 70 per cent of plantation coffee is in open competition with the mass production from areas cultivated by natives; and although the liquoring qualities of the latter may be somewhat inferior it has the advantage of being available in bulk with a certainty of delivery, and it is cheap.

If coffee were sold on a basis of liquor alone, plantation produce might be able to maintain a separate market; but the fact that "B"s and "C"s of any one parcel are considerably cheaper than the "A"s and "PB" proves that this is not so. The "A"s and "PB" of good liquor are the fancy parcels to which I have referred; the balance, which is not so handsome in appearance though carrying the same intrinsic qualities of liquor, is used for blending, and is the subject of this article.

Coffee for consumption is offered for sale by retail grocers, who get their supplies from wholesale coffee blenders and distributors, who, in their turn, depend on the import coffee merchants and warehousemen for their requirements as and when they occur. This is the trade, and neither the retail nor the wholesale grocers can afford to deny themselves this facility which provides them with a choice from a large and comprehensive stock instead of the risk incidental to the importing of coffee and the uncertainty of quality to suit their special requirements. It is business, not philanthropy, that the trade is interested in, and a study of the business methods employed might give a better conception of market requirements than is at present held by the average planter.

The public obtains its coffee in a variety of ways, of which the following are principal examples:—

(*a*) In the bean or ground, as a straight coffee; that is, as a particular coffee unmixed with other coffees.

(*b*) In the bean or ground, as a blend of two or more coffees.

(*c*) As a "brand" coffee, containing chicory and/or other ingredients.

(*d*) As a coffee essence.

Comparatively little coffee is consumed straight; that is to say, unmixed with other coffees or with chicory. The annual consumption of coffee and chicory in Great Britain is 15,000 and 5,000 tons respectively. To normal consumers a mild though well liquored coffee appears insipid. This is due partly to the fact that the public is not educated in the art of preparing coffee, and partly because, being expensive, the amount necessary for a good brew is seldom used. Something

with more body and more economical in use is far better suited to the public taste, and is provided in the popular blend.

To the average grocer, a 1/6 blend is of far greater importance than a 2/4 to 4/- super mild coffee, because the greater demand for the former makes it a better commercial proposition, and he supports it by passing on this demand to the wholesale blender and distributor. He, in turn, demands from the importer, who buys forward to maintain stocks for potential needs, and thus occasions a demand for such coffees as form the base and main ingredients of the popular blends.

There are several blends; every wholesale blender is continually experimenting with combinations of various coffees, based on some particular type which is standard in quality and readily available in quantity. He might use more than one coffee as the base for his blends, but they must all be of standard quality and available in bulk. These experiments are carried on until he produces the blend best suited to his consuming public, but there is a price limit, and it is this that governs the purchase of the ingredient coffees, the characteristics of which he tests every day, utilizing only the cheapest if it gives him the requisite result.

Some of these blending coffees are not available in bulk, but are obtained as individual parcels at auctions held in London and are there bought in by the coffee merchant and stocked. Some are re-sold to be consumed straight, but the greater proportion lie in the warehouses awaiting absorption as ingredients in one or other of the several blends in process of preparation. Owing to the comparative expense incidental to the acquiring of these individual parcels and the cost of warehousing them pending demand, the selling price to the blender is very much higher than that demanded for the bulk varieties. This is one of the reasons why the retail price of straight coffee remains high in spite of the reduced price now paid to the producer.

In contrast to these blending coffees which, be it noted, are on offer, we will now consider the basic coffees which are in demand. This demand, which is the very essence of successful coffee marketing, originates with the consumer and works its way back to the producer. It is a demand for a standard quality coffee which can be bought forward in bulk, and therefore commands, by virtue of competition, a higher price than that paid for smaller parcels of the same quality and even of a slightly superior quality.

It will be appreciated that when the marketing conditions of a coffee change from the state of being on offer to that of being in demand, they increase the price paid to the producer whilst reducing the retail selling price because of the reduced overhead expenses incidental to purchase and the reduced cost of warehousing. This reduced selling price tends to increase consumption, and so effects a double advantage to the producer.

A bulked coffee, whatever the quality may be, will always attract buyers because of its ready utilization by the trade. It permits of speculation and a quick turnover, and is keenly competed for. Moreover, merchant houses will themselves probe the possibilities of every market and get the best prices available, which ultimately works back to the producer. The following extract from the Kenya Coffee Board Bulletin for July, 1936, will illustrate this:—

"An encouraging aspect of sales to London during the season has been the growth of direct shipments by local dealers to London wholesalers. These shipments are beginning to fill the requirements of London for lower grades and average quality coffees, which are

essential as 'fillers', and the reductions in costs and charges obtained in this method of trading begin to be reflected in better prices paid to planters. For example, 'C' grade coffee sold in London throughout the season at an average price of 38/6 per cwt., which is equivalent to, at the most, 26/6 in Nairobi, whereas bulk shipments of 'C's to London to supply distributors' requirements have been purchased in Nairobi at an average price of 29/- per cwt."

What is a bulk coffee? It is a coffee of which there is a potential and visible supply available in bulk, which can be sold forward. To sell coffee forward means a contract, and that contract can only be entered into where there is a definite and assured supply. Where individual sales occur, the supplies are dependent on the whim of the individual producer, and merchants cannot afford to commit themselves to any such uncertainty. Producers must first bind themselves into a co-operative body which can contract and sell on their behalf. Then, and then only, can they offer a standard quality coffee in bulk, on which assurance it will eventually become a base or main ingredient in some special blend, with the attendant advantages of a demand market.

Consider the case of the British car in East Africa. For years the manufacturers looked on this market from their own point of view entirely. They offered an article second to none in durability and workmanship, but failed to consider market requirements in terms of gear ratios and clearance, with the result that sales remained low in spite of Empire propaganda to "Buy British." It was not till adjustments had been made to suit local conditions that any appreciable sales were effected; and in like manner it may be well for representatives of the producer if they were to pay less attention to merely advertising the merits of their produce and more to trade requirements.

There are sceptics who will deny this fact and maintain that quality alone will suffice. For their information the following comparative figures showing the average price paid in Nairobi auctions for Kenya coffee (excluding the "A"s and "PB") and for Bukoba coffee, "Plantation FAQ" (Arabica), may be of interest. Sh. 50 per ton has been added to the price of "FAQ", f.o.b. Bukoba Pier, to cover the railage to Nairobi. During May, June and July, no auction sales were held in Nairobi.

Average Price in £ per Ton of Coffee Sold in 1936.

	Kenya.	*Bukoba.*
January	£31/6	£29
February	£31/18	£32/2
March	£29/3	£35/6
April	£26/5	£32/10
August	£30/13	£32/14
September	£33/9	£32/13
October	£35/17	£32/17
November	£38/15	£36/13
December	£41/18	£41/3
	Kenya.	*Bukoba.*
Total tonnage	3,609	2,347
Average overall	£34/12	£33/7

In actual quality and appearance, the one is infinitely superior to the other: Kenya coffee with the advantage and expense of plantation culture and preparation, and Bukoba "FAQ", a native-grown, *buni* coffee; but whereas the former is offered in small individual lots, the latter is a standard quality coffee and it is available in bulk.

Local auctions have given the trade an opportunity of presenting plantation coffee in bulk, but until such time as planters awake to the advantages and facilities provided by these auctions, and support them by disposing of more of their produce locally, exporters are unable to cope with the demand, nor, with the present uncertainty of supplies, can they commit themselves to the risk of any considerable contracts forward.

Having adopted means of meeting the trade to mutual advantage, the next essential is to co-ordinate all efforts to stimulate consumption, and so to improve the market for coffee generally that the demand will keep pace with the rapidly increasing production.

If my argument in favour of bulked supplies is accepted, it follows as a corollary that salvation lies through the sale of blended coffees and not merely in the advertisement of any particular variety. Provided that plantation coffees maintain their superior liquoring qualities and high standard of crop preparation, and are presented in bulk, the competition from inferior produce is confined to its own class. Furthermore, the latter, instead of being a competitor, assists its neighbour by providing a cheap base on which to build a moderate-priced blend in which the bulked offerings of plantation coffees figure as the principal ingredient.

This brings us to an important conclusion, namely, that cheap native coffee, provided it be of good quality, and the higher class coffees are complementary and not competitive; that the one is essential to the sale of the other, as it is only through the medium of blends that the latter can reach the main consuming public; and the greater the output of these cheap bases under official guidance, the greater the opportunities offered the capitalist planter in the profitable disposal of his crop.

It has been said that Great Britain consumes only the best quality coffee. This is but the half truth. The other half is that the consumption of coffee is confined to the higher classes to whom the cost of purchase is of little consideration, and no concerted effort has yet been made to cater for the slender purse of the multitude. The retail price of a good class coffee in America, roasted, ground, and well-packed for delivery, is not much more than 6d. a pound. Is there anything to compare with this in Great Britain?

The following statement shows the consumption of coffee in Great Britain compared with other countries, in pounds *per capita*:—

	1913.	1922.	1928.	1936.
U.S.A. ...	8.90	10.97	11.78	11.96
Denmark ...	12.99	14.56	18.86	15.78
France ...	6.49	9.99	9.85	9.14
Germany ...	5.36	1.32	1.35	4.83
Sweden ...	13.64	13.21	13.26	16.07
Great Britain ...	0.78	0.86	2.59	0.75

American and Continental "coffee" manufacturers have, for years, been exploiting this potential market with "brand" coffees and coffee essences, and have succeeded to some extent in popularizing this "coffee" in competition with tea and cocoa. This is no mean achievement, but it has been accomplished at the expense of pure coffee. Grocers are finding that the growing popularity of these synthetic products, which have the advantage in price and convenience and economy in use, is seriously affecting the sale of pure coffee. It is becoming increasingly difficult for them to maintain their custom and, at the same time, the high standard of their blends. Many are being forced by competition to seek low-priced substitutes for their ingredient coffees, and are looking to cheaper markets for their requirements. Hence the prices offered to-day for the 70 per cent plantation coffee under discussion.

Governments and financial houses with vested interests and sunk capital have bought in, and continue to buy in, large stocks in order to regulate the supply and maintain the price level of mild coffees. It behoves the producer to profit by this interim assistance and to do all

in his power to stimulate the actual consumption of coffee, as opposed to the synthetic productions offered in its name. It is not merely the consumption of this or that variety that matters; it is the aggregate consumption of all coffees that governs the aggregate demand, and this aggregate demand controls the price paid to the producer.

What does the British public know of coffee apart from the fact that it tastes well in hot milk on a cold day? Does it know that coffee is a food; that in the country of origin it is a food to-day; and that the fighting races of Central Africa used it as their "army ration" in times of war? Do they know of its stimulating and sustaining properties, and, if not, would not this knowledge promote a demand for a cup of real coffee by the millions of workers in our big industrial centres, instead of the mere apology for coffee served to them to-day?

Coffee marketing boards, marketing groups, co-operative societies, and all responsible bodies promoting the welfare of Empire coffees would do well to consider this matter, and to divert some of the money spent merely on the advertisement of quality to the pooled resources of wholesale blenders, distributors, and all who are engaged in the trade, with the object of combating these spurious concoctions by educating the masses at home to a knowledge of pure coffee and to the right method of preparation. Synthetic productions have brought about the collapse of more than one basic industry, and jeopardize the future of coffee to-day.

Some Recent Advances in Soil Physics

The following extracts are from an article written in 1935 by Sir John Russell, Director of the Rothamsted Experimental Station.* The purpose of the annual publication of the Royal Agricultural Society of England in which the article appeared is "to spread the lessons of research among those to whom they are likely to be of the greatest use by giving the farmer information on the results of the year's work of the experimental stations in a summarized and simple form." The audience Sir John Russell was addressing was thus primarily the farmers of the British Isles. In the next number of this Journal the same subjects will be discussed by the Amani Soil Chemist in an attempt to relate the conclusions to conditions as found in some East African soils:—

Soil Tilth: Building up the Soil Crumbs.

One of the chief purposes of soil cultivation is to build up the soil particles into crumbs of the best size for plant growth. Good farmers in various parts of the world have discovered empirically how to do this, and scientific workers are trying to understand the mechanism of the process. Crumb formation is being studied in the Soil Physics Department at Rothamsted. It is shown to depend on the clay and on the wetting liquid—some liquids will form crumbs and others will not; water is one of the best and petrol one of the worst. The relations between the chemical and physical properties of the clay and its power to form crumbs has been investigated by E. W. Russell,[1] and a hypothesis has been put forward to link up and explain the observed facts. The actual making of the tilth is done by the weather; what the farmer must do is to choose the operations that are right for the weather at the time he is working.

The chief water supply for the growing plant is what is held in the capillary pores of the crumbs; the amount of this capillary space, therefore, determines the amount of water the soil can hold for the plant. The spaces between the crumbs (interspaces), on the other hand, form the channels down which excess of water can drain away and through which air can circulate to the plant roots. In wet regions it is obviously desirable that the interspaces should form a considerable part of the total pore-space; in dry regions, on the other hand, the capillary pore-space of the crumbs should form a larger proportion. Recent measurements in Russia by Dojarenko show that, in the wet region around Moscow, the interspaces should form about 50 per cent of the total, the capillary pores forming the other 50 per cent; while in the hotter, drier region of Samara, Kvasnikov showed that the interspaces should form only about 25 to 35 per cent of the total, the remaining 65-75 per cent being capillaries.[2]

The Breaking Down of the Crumbs: Soil Erosion.

When the crumbs break down the soil in a wet region becomes a sticky slime, difficult to cultivate. In a dry region it becomes a dust that may easily blow away. This is very liable to happen where the land has been cultivated for a certain number of years, particularly where, as often happens, there has been a fallow every second or third year. The organic matter that helped to bind the crumbs

* E. J. Russell, 1935: *The Farmer's Guide to Agricultural Research in* 1934, pp. 207-212.

becomes oxidized; already about one-third of it has disappeared from some of the Canadian and United States soils, and this may involve not only the loss of nitrogen but, what is far worse, may lead to the loss of the entire soil. The soil aggregates are broken down to a fine dust which readily blows about, causing the dust storms that are so annoying to the traveller. The surface soil, including the young crops, may be completely carried away. In the United States some eleven million acres have been abandoned because of soil erosion; so serious is the loss that special experimental stations are set up to deal with it, and a colossal wind break, 1,000 miles long and 100 miles wide, is to be planted in the next ten years from the Canadian border to the Texas Panhandle at an estimated cost of 75 million dollars. Western Canada and parts of Africa have suffered severely. In Queensland actual erosion has been less serious, but the deterioration in physical condition has been very marked, and the nitrate that accumulated during the decomposition was harmful because there was too much of it, and the cotton grew rankly and fruited badly.[3] The problem in Kenya has recently been discussed by V. A. Beckley.[4]

Soil Water Relationships.

The water relationships of the soil have been, perhaps, more fully studied than any other soil factors concerned with plant growth, and the vast accumulation of knowledge is now being put into definite order. The general divisions by "wilting points" and "moisture equivalents", introduced in 1897 by Lyman Briggs and later associated with McLane and Shantz, have stood the test of time, and still remain the best of the measures that we have. The "wilting point", as its name implies, represents the percentage of moisture left in a soil when plants just begin to wilt; it is the amount of water held too firmly to be extracted by the plant. The "field capacity", approximately measured by the "moisture equivalent", apparently represents, for many soils, the largest amount of water that a well-drained soil can hold; whatever can drain away has gone, but this balance will remain until it either evaporates or is taken by the plant. These amounts vary greatly in different soils; some of the results obtained by Botelho da Costa and R. K. Schofield at Rothamsted[5] are as follows:—

Moisture Contents of Typical Soils at the Different Stages of Drying Out.

(*R. K. Schofield and J.V. Botelho da Costa*)

Soil	Just too dry for plant growth		Properly moist.	
	Wilting Coefficient (plants wilt).	The new pF scale.	Moisture equivalent.	The new pF scale.
Sandy	2.88	4.02	11.51	2.70
Chalky	3.09	4.24	24.28	2.70
Sandy organic	3.67	4.16	12.16	2.69
Loam	4.60	4.35	15.11	2.51
Heavy loam	13.37	4.40	29.30	2.94
Clay	21.55	4.09	31.40	2.96

These figures show the difficulty of interpreting the meaning, so far as the plant is concerned, of the percentages of moisture in the soil. For example, a moisture content of 20 per cent would mean, for soil No. 1, complete water-logging and asphyxiated plant roots. For soil No. 2 it would mean a very favourable condition for growth. On soil Nos. 5 and 6, however, the plants would have wilted and probably died before the drying had got so far. This trouble looks like being finally overcome by the ingenious method devised by R. K. Schofield of measuring the water, not by its actual quantity, but by the hold which the soil has upon it; he uses a logarithmic scale called the pF, analogous to the well-known pH or soil acidity, so that he can express the water content from the point of view of plant growth, which of course is the important thing.[6]

Water Movements in the Soil.

In recent years there have been great changes in our ideas of the mechanism of water movements in soil; the older conception of capillary films, which figured so much in the literature thirty years ago, has been abandoned by soil experts. On this older idea water added to a soil was supposed to spread itself almost uniformly over the whole body of soil so long as the particles were in actual contact, and any thinning of the capillary film in one part of the soil caused an immediate transfer of water from the moister parts. In like manner, the addition of water, either from rain or irrigation, affected the whole mass by thickening all the films. This is now known to be incorrect; upward capillary movement of the sort that used to be demonstrated in long glass tubes filled with soil and stood in dishes of water is now recognized as quite unimportant, for reasons set out by W. B. Haines at Rothamsted and by Buckingham in the United States. Shaw, Veihmeyer and others working in California have shown experimentally that added water moistens just so much of the soil as it can fill up to the "field capacity", and that any further movement after this is very slow. A sharp boundary remains for some time between the part of the soil so moistened and the adjacent parts which remain dry. Water may still be transferred by evaporation and condensation, as shown by Lebedeff, and in some cases this may be an important supply of moisture. There is, however, no important transfer by capillarity. In dry regions the moisture in the soil at a depth of 8 in. is almost unaffected by the evaporation that takes place at the surface, and by the shallow cultivations made to conserve the soil moisture. Fruit trees (peaches and prunes) may draw their water supply from the top 6 ft. of soil but not more; they wilt if this top layer is dry no matter how much water there may be lower down. Trees can utilize with almost equal ease all the water between the "field capacity" (practically the same as the "moisture equivalent") and the wilting point; the ideal course therefore is to moisten the soil to its "field capacity" and to the depth penetrated by the roots, but no deeper.[7] This discovery has proved of great importance, and in Viehmeyer's hands has revolutionized irrigation practice in California, and looks like solving that most difficult problem in all irrigation schemes: how much water should be given to the cultivator to ensure the best results? Knowing the percentage of water actually present in the soil and the depths of the plant roots, it is easy to calculate the quantity of water per acre that must be added to raise the water content up to the moisture equivalent of the soil which has been determined once for all by the soil survey. Water can be

added in excess of this quantity if salts are present in the soil so as to wash them down; in some cases the salts have been driven 25 ft. below the surface.[8] The Californian water engineers have systematized and organized the work admirably, and they have been able to effect great economies in the use of water and to avoid spoiling of much good land by the application of excess water.

It might be asked: What is the practical use of knowing how the water moves in the soil? What does it matter whether the old theory of capillarity was right or wrong? The answer is that new practices such as water supply for irrigation are very much influenced by current teaching of agricultural science and that if this is ill-founded the practical recommendations suffer. It is only since the modern ideas of soil moisture relationships have been developed that sound control of irrigation practice has become possible.

Dry Farming and the Soil Mulch.

Another example of the need for the sounder knowledge is afforded by the so-called "dry farming" practice. So long as it was held that water moved in the soil by capillarity it was obviously right to recommend farmers in dry countries to fallow, and to keep on cultivating the fallows so as to break the capillary tubes at the surface and maintain a fine surface mulch that would prevent them reforming. Frequent disking and the production of a dust mulch were confidently recommended, and were considered the best practice. Now that the ideas on capillary movement are so radically altered it is recognized that this recommendation was wrong. A mulch is very desirable, and a straw or dead vegetation mulch would be one of the best; weeds must be rigidly kept down, but apart from this no cultivation appears to be necessary, and the formation of a dust tilth is now known to be positively harmful.

Drainage as Affected by Soil Structure.

The other problem of dealing with the removal of free water which might be harmful is very important on heavy clay soils where drainage is necessary, and farmers ask advice as to the proper depth and distance apart of the drains. On the old idea of free capillary and inter-capillary movement the water table would be expected to sink uniformly and continuously on drainage, and some pleasing mathematical formulæ were set up to give the necessary distances between the drains. Recent experimental work, however, indicates that the fundamental assumption is wrong; the water does not soak away uniformly and continuously. These heavy soils have the curious property of splintering on drying into blocks of characteristic but irregular shapes and of various sizes, separated by cracks varying from visible to invisible dimensions. It is almost certainly down these cracks, and not through the pores, that the water drains away;[9] and in passing it often deposits organic matter and oxides of iron and manganese which give a darker colour to the surfaces of the cracks. Experimental drainage fields have now been set up in Prussia, Poland, Finland and elsewhere, and these may be expected to furnish material for a better treatment of the drainage problem than exists at present.

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Composts and Composting

(*Continued from Vol. II, No. 5*)

By V. A. BECKLEY, *M.C., M.A., A.I.C., Senior Agricultural Chemist, Department of Agriculture, Kenya Colony.*

In the Indore technique as originally described,[3] a very detailed and comparatively complicated time-table is given. Perhaps, in Indore, exact adherence to the time-table may give a noticeably better product than that resulting from any deviation. The time-table may also suit Indian ideas but, with Africans, as simple a time-table as possible is needed. Mr. H. E. Lambert, while District Commissioner at Embu, utilized the *boma* wastes as a demonstration, and modified this time-table, but followed the other details fairly closely. Instead of odd intervals between processes, an even interval of seven days was used, thus all operations occur on the same day of the week. This simplifies matters considerably, and for those who have not read the description in the Kenya bulletin[1] details are given in an appendix.

Taking into consideration the basal ideas in compost-making, Mr. Wolryche Whitmore has developed a very useful technique. All crop residues are carted to the various cattle *bomas*, which are scattered about the farm. Here they are stacked and used as bedding in the *bomas* where the bedding lies for a week or more. The trampling crushes the coarse material, such as maize stalks, and coats everything with dung. The bedding is removed and stacked in heaps, where it is watered and turned when necessary. The quantities of good manure produced yearly are such that I fear to quote the figures, but Mr. Wolryche Whitmore is able to keep his large farm in wonderfully good heart.

In the usual Indore method, although the heap is never saturated, a fair amount of water is needed. On many farms it is difficult to arrange a supply of water near the compost factory. Usually the waste has to be carted. Any technique which will reduce the water requirements will be of great benefit.

The writer for some years has composted all his garden wastes, depending upon rainfall only. By an accident it was observed that if beans were allowed to grow on the heap, decomposition was more rapid. The beans, too, nodulated well; peas, the other garden legume which might be expected to do well, usually failed. The same problem has been attacked at the Institute of Plant Industry, Indore, and a technique involving the growing of a legume evolved.[5] Here, Sunn hemp (*Crotolaria juncea*) was found to be the most successful legume; at the Scott Agricultural Laboratories this failed, as did two other Crotolarias. However, anyone trying this method would be well advised to make experiments himself. Details of the system were published in Kenya three years ago,[1] and large quantities of compost have been prepared using rainfall alone.

Rain will not penetrate beyond a certain depth into a pile of, say, grass. A zone of saturation develops, at the bottom of which a slimy film is formed. Incidentally, the use of a very heavy mulch of grass forms a thatch, which is impervious to air and water. Thus, in order to get the heap wetted evenly in the initial stages, the heap must be turned after saturation to some depth. Once decomposition has proceeded beyond a certain point water penetrates readily.

It is best in this method to use the wastes as bedding for stock, to get them crushed and impregnated with dung and urine, but it is possible to use wastes alone. In the writer's garden compost heap even thick woody prunings break down, Kei Apple thorns being the only truly resistant things. During the dry season as well as the rains, the used bedding is stacked in long heaps, about three three high. Even in dry weather there is some preliminary action. In the rains, when the heap has been wetted to the depth of saturation, a depth that varies according to the nature of the wastes, it is turned to mix the wet with the dry. If the heap has been built during the dry weather, just before the rain is expected, spread the head out into a shallow, wide heap; after the first good storm it is mixed well, and again built up into the tall heap with pitched slopes. Phosphate and any wood ash available may be added before mixing with advantage. Fermentation will take place, giving high temperatures. After a fortnight or so, if there has been rain to wet the outside, the heap gets its first turn; if there has been no rain, wait until the outside is wetted before the turn is given. The legume is sown on the new heap. The roots permeate the heap, and, by virtue of their bacterial nodules, increase the nitrogen content. After a month, the heap is again turned, incorporating the green material in the turning. Provided there has been sufficient rain, the material will have broken down into a loose, powdery compost, ready for use six to eight weeks later. With plain wastes and no dung, the time for decomposition may be longer.

If it is not possible to use the compost when ready, it should be piled into heaps with steeply sloping sides, and thatched to keep out water. In this stage it will very readily absorb water, and may set to a hard mass. There is a deterioration in quality in a properly built storage heap, but better a slight loss in quality than not use compost.

An interesting technique has been evolved by Mr. C. Tofte while employed by Messrs. Norton & Giffard of Kiambu, resulting in the production of a very usable compost at a cost of Sh. 2 per ton. As this will shortly be described in detail, suffice it to say that the major part of the moisture needed in the compost is supplied by the natural water of the basal material, Napier grass. The principles of composting are closely followed with one exception: in order to conserve moisture the heaps are compacted.

There is one waste produced in enormous quantities which has given a great deal of trouble in composting—sisal waste. This has been successfully treated at Major E. Grogan's Taveta Estate by using the basal ideas of the Indore technique, and is quoted in Sir Albert Howard's lecture to the Royal Society of Arts.[4] Briefly, the waste is drained on slatted trucks and then conveyed to the compost factory, where it is stacked on a platform of sisal poles, mixed with Napier grass and any wastes available, and inoculated with material from an old heap. The sisal pole platform serves a double purpose: it allows excess water to drain away and, above all, it aerates the mass, the greatest difficulty so far encountered in composting sisal waste. The heaps receive two turns, and break down into a loose, powdery mass of valuable compost. [An article on the technique for sisal composting employed on this estate will shortly appear in the Journal.—*Ed.*]

In none of these cases can it be said that the method used is the exact Indore technique. In the first, the details of the Indore technique are fairly closely followed, but modified to meet local conditions. In the second, the material is stored until rain wets the heaps. In the third,

use is made of the natural water-content of the material composted, with reduced aeration. The last involves far more aeration than is called for by the original method. *In every case a valuable compost has been produced, not by slavishly following details, but by the application of the basal ideas to the conditions.*

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APPENDIX.

Indore Technique as Modified by Mr. H. E. Lambert (p. 42 of Bulletin No. 9 of 1934).

APPENDIX

Modified Indore Technique.

All wastes of every sort are collected and stacked, in layers, in order to obtain as even a mixture as possible. If there is plenty of stock on the estate the wastes should be used as bedding, leaving them in the *bomas* long enough for coarse materials to be crushed. If there are only a few stock it will be necessary for all coarse materials to be crushed. Dung from the *bomas* should be collected and stored in a wet state. All wood ashes, too, should be collected.

While urine earth is not essential, it will be to the benefit of the stock to have all urine-soaked earth removed and replaced by dry soil, which may advantageously be that collecting in the farm drains.

The pits should be in units of four, to simplify timekeeping, and of such a size that each will, when filled, contain 18 to 24 inches of material. It will be found easier to work a number of units of small pits than one or two units of large pits. Small pits are easier to fill, turn, water and generally control. Let the maximum size be 30 feet by 12 feet. which, filled to a depth of 2 feet, will contain about five tons.

As, during the rains, it will not be possible to use the pits, enough space should be left between each unit to allow of heaps being constructed. It is possible always to build heaps above ground, but it will be found they are liable to dry out in dry weather; hence the insistence on pits.

Soiled bedding, when removed, is stored in a moist condition near the pits. Where the wastes cannot be used as bedding, enough is stored in a moist condition for at least a week, next to the pit it will occupy, to undergo a preliminary fermentation.

Filling.—In order to provide a good nidus for the active microbes, the material is moistened with a slurry of dung, wood ashes and soil in water, which coats the individual particles, ensuring even wetting. For this purpose, about two *debies* of fresh dung, three of soil or urine earth and half of wood ash per 30 cubic feet are allowed. It is also recommended to add 2 to 5 lb. of a cheap, soluble phosphate, i.e. for a pit of the maximum size, 45 *debies* of dung, 70 of soil, 10 of wood ash, and 45 to 100 lb. phosphate would be allowed.

It will be found advantageous to divide the pits into five equal sections, and fill from one end, completing one section at a time, each section in the large pit

suggested receiving one-fifth of the additions.

Draw material from the pile adjacent to the pit and spread it evenly in a layer, not more than four inches thick, using a rake to even the layer. Moisten each layer with the slurry, using two to three *debies* for each layer. Over each layer scatter material from a pit fourteen days' old. When a section is complete, start the next section dead against it to maintain a continuous bank. After the whole pit is filled, water the whole, using some six or eight *debies* of water, repeating next morning. The filling is completed in one day and should not be spread out over several.

If the weather be dry, water at the end of a week, *on the same weekday as the pit was filled.* If raining, the watering will not be required.

The first turn is given a fortnight after filling, taking material from top to bottom of the heap, scattering it over the whole of the untouched portion in thin layers, watering each layer lightly, say half to one *debi* of water. The criterion for correct moistening is an even glistening over the material. This is continued till one-half the heap is folded over the other half. While this turn is being done, inoculate again from a pit fourteen days older.

A week later the pit is given a light watering after the third turn. Three more waterings are given at weekly intervals, and then the compost is removed. The full time-table for one unit of four pits is given in the following table:—

TABLE V

PROGRAMME FOR SINGLE UNIT OF FOUR PITS

Day	Pit 1	Pit 2	Pit 3	Pit 4
1 (1st Monday)	*Charge.* Inoculate from Pit 4.	Fourth watering.	Second turning.	First turning. Inoculate from Pit 3.
8 (2nd Monday)	First watering.	Fifth watering.	Third watering.	Second watering.
15 (3rd Monday)	First turning. Inoculating from Pit 4.	*Remove. Recharge.* Inoculate from Pit 1.	Fourth watering.	Second turning.
22 (4th Monday)	Second watering.	First watering.	Fifth watering.	Third watering.
29 (5th Monday)	Second turning.	First turning. Inoculate from Pit 1.	*Remove. Recharge.* Inoculate from Pit 2.	Fourth watering.
36 (6th Monday)	Third watering.	Second watering.	First watering.	Fifth watering.
43 (7th Monday)	Fourth watering.	Second turning.	First turning.	*Remove. Recharge.* Inoculate from Pit 3.
50 (8th Monday)	Fifth watering.	Third watering.	Second watering.	First watering.
57 (9th Monday)	*Remove. Recharge.* Inoculate from Pit 4.			

Where stock are not available and the wastes consist mainly of strawy materials, it will be necessary to add some nitrogenous compound, such as sulphate of ammonia, to accelerate the decomposition. The amount needed will depend on the nature of the wastes; 20 to 40 lb. of sulphate of ammonia, dissolved in the slurry, should be ample for the largest pits recommended. Everyone will, however, have to ascertain for himself the amount necessary.

Researches on Agave Fibres*

By F. J. NUTMAN, *M.Sc., A.R.C.S., D.I.C., Plant Physiologist, East African Agricultural Research Station, Amani, Tanganyika Territory.*

Research on fibre-producing *Agaves* has been handicapped by the absence of any recorded body of scientific information regarding the plant or the fibre. During the past six or seven years work at Amani has gone a considerable way to remedying this state of affairs.

The Geneticist, having previously confirmed the view that all sisal in East Africa is a clone, has studied in detail its vegetative characters and development over a period of several years. The first part of this study will shortly be published. His results, some of which are of direct practical applicability, are mainly useful in that they provide the foundation of our knowledge of the plant itself. This knowledge is essential to any well-designed field experimentation. The remarkable progress made at the Sisal Experimental Station at Mlingano owes much to the existence of this information at the time when its experiments were planned.

On the other hand, I have confined my attention to the *fibre*. The object of my studies was twofold: in the first place to fill a gap in our knowledge; and secondly to discover some criterion whereby selection of new *Agave* species or hybrids could be facilitated.

It is obviously impracticable to propagate all the new plants that may be raised to the extent necessary for the provision of adequate fibre samples for trade assessment, even if the trade were able accurately to judge their desirability, which is far from certain. I have therefore attempted to measure certain fibre characters, so that a single new plant can be compared with others, or with sisal as a standard. Thus, early in the history of a new variety, a judgment can be made, based on fact and not on opinion, as to whether its fibre justifies multiplication and testing.

The discovery at Amani of the new *Agave*, locally known as "Blue Sisal," has afforded an opportunity for the testing of the accuracy of conclusions reached through fibre studies. Up to the present, every prognostication made has been borne out in practice.

THE FIBRE IN THE LEAF.

Plate I shows the appearance of cross-sections of mature leaves of *A. sisalana*, *A. amaniensis* and *A. cantala*. They are generally similar; in fact, all *Agaves* show the same basal arrangement of the fibres in their leaves. Three zones can be delimited:—

(1) A peripheral zone, composed of one or more irregular rows of small fibres, of nearly circular cross-section.

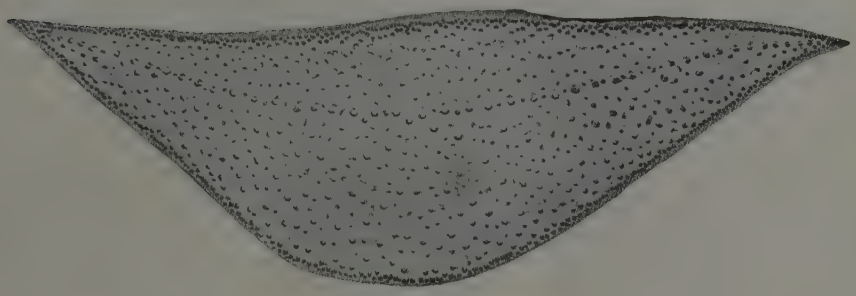
(2) A median line of large fibres. These are broadly crescentic in section, containing a conducting strand within the crescent. Opposite to this is a similar, smaller fibre, also somewhat crescent-shaped.

* This article is a summary of Part I of a recent paper in the *Empire Journal of Experimental Agriculture*, 5, No. 17, p. 75. I have here avoided lengthy descriptions of how the results were obtained, and have omitted a discussion of grading problems, since an article on this has already appeared (*East African Agricultural Journal*, I, No. 2, p. 101).

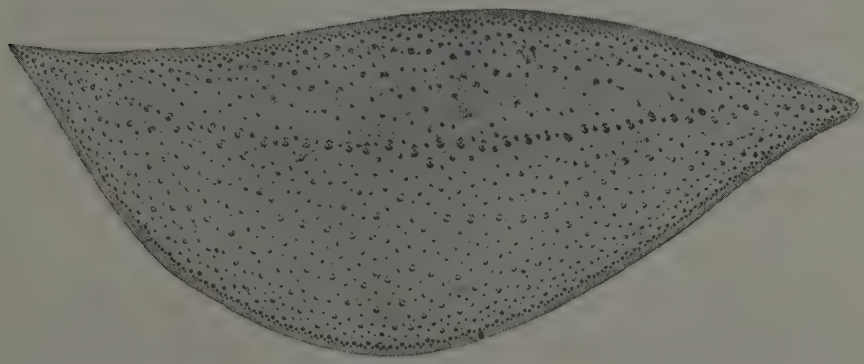
A summary of Part II, dealing mainly with the mechanical characteristics of fibres, may appear later.

PLATE I

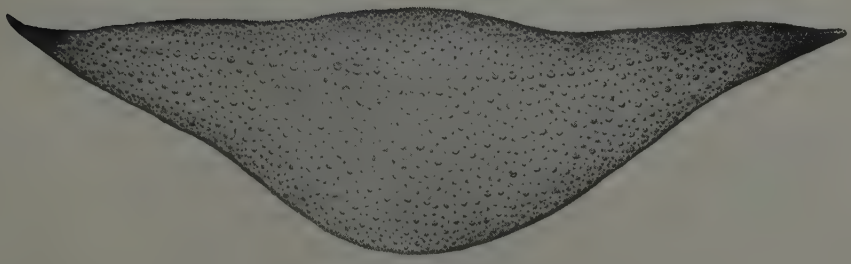
Cross sections of Agave Leaves



A. sisalana



A. cantala



A. amaniensis

(3) Fibres scattered throughout the ground-tissues of the leaf. These form an almost complete transition-series between the fibre-types of zones (1) and (2).

Agave species vary considerably in the total number of fibres per leaf, and in the partition of these into the different types. The following three types, all fairly clearly defined, can be distinguished: —

(1) *"Mechanical" Fibres.*

These are most strongly developed round the periphery of the leaf, although they also occur scattered through the leaf parenchyma. They are small, rarely circular in cross-section, and usually of a more or less thickened horse-shoe shape. They are rarely associated with conducting tissues. They vary in length from a few centimetres to almost the entire length of the leaf. These fibres are of great importance commercially, as, owing to their shape, they seldom divide during the processes of manufacture. The "fineness" of a fibre-sample therefore depends, from a commercial viewpoint, almost entirely on the fineness of these fibres.

Figs. 1, 2, 3 and 4 illustrate cross-sections of fibres of this type from different *Agave* species. Each fibre is composed of a large number of smaller, spindle-shaped cells, fitting closely together, somewhat like the cells of a honeycomb. Each of the smaller units in the drawings is a cross-section of a cell of this type. The cells have thick, strong walls, and are empty. The species show considerable differences in the size of the individual cells, and the relative thickness of their cell-walls. One would expect that a fibre composed of small cells, with thick cell-walls and relatively small internal air-spaces, would be a strong one; and thus, on the basis of microscopic evidence, one would arrange the fibres illustrated in order of strength, *A. cantala*—*A. amaniensis* — *A. sisalana* — *A. fourcroydes*. Actual measurement confirms the correctness of this expectation.

(2) *"Ribbon" Fibres.*

These invariably occur in association with the conducting tissues. They are most strongly developed in the median line of fibres previously referred to, though "ribbon" fibres of various sizes are present in all parts of the leaf, excluding the extreme periphery. Each fibre is seen in section as a wide crescent, with the phloem of a vascular bundle in the open side. It is of normal fibre-structure, and of considerable mechanical strength. It forms part of the fibre of commerce, and is noteworthy as being the longest fibre in the leaf. These fibres run from base to tip, and if the fibres of a leaf are classified on the basis of length, the longest classes are entirely composed of these fibres. They are also important in that they readily split longitudinally, and in this way form a contrast to the mechanical fibres. The fineness of commercial fibre, therefore, is not dependent upon the original size of these fibres.

(3) *"Xylem" Fibres.*

I have used this name because these fibres occur in conjunction with the "xylem" or woody portion of the conducting tissues. They are thin-walled, very weak, and invariably fragment during decortication and pass into the waste. They are of no commercial importance.

Plate II shows the component parts of a bundle from the median line of fibres in *A. sisalana*. It shows the strong large fibre of the "ribbon" type, the weak "xylem" fibre, and the conducting tissues between the two.

Plate III illustrates part of the edge of two leaves, one being *A. sisalana* and the other *A. amaniensis*. The larger number of finer fibres in the latter is apparent.

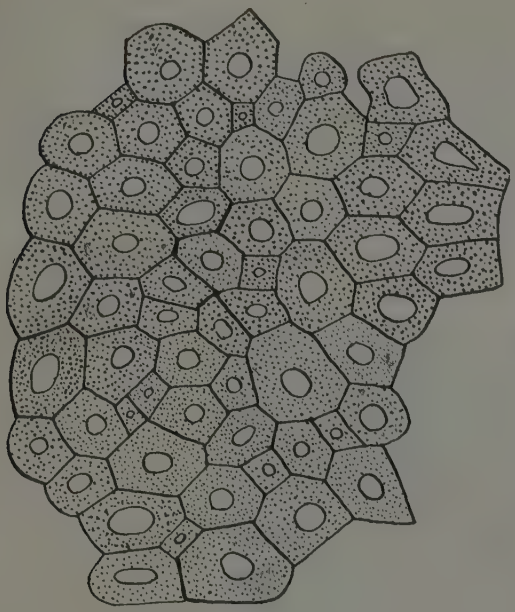


FIG. 1
Fibre of *Agave cantala*

FIG. 2
Fibre of *Agave amaniensis*

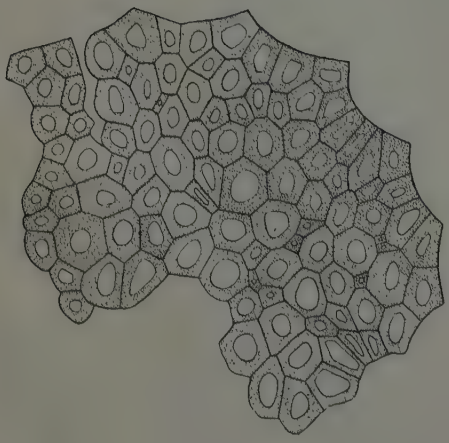


FIG. 3
Fibre of *Agave sisalana*

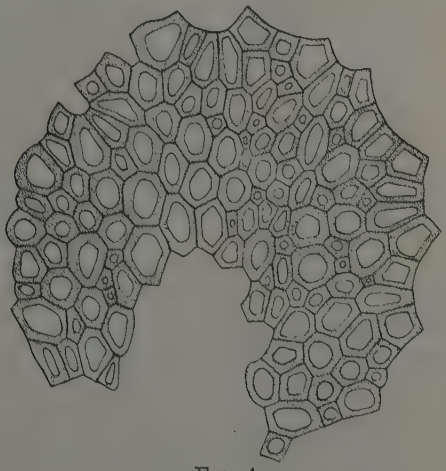


FIG. 4
Fibre of *Agave fourcroydes*

We can thus suggest certain characters that should be advantageous in any new selection or hybrid, as follows: —

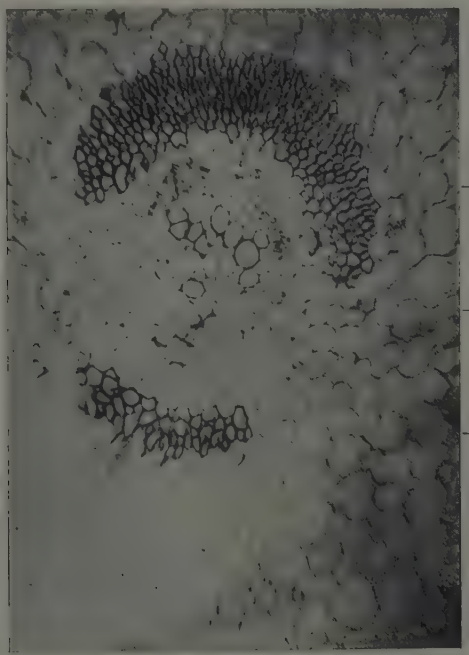
(1) Dense fibres, the constituent cells of which are thick-walled, and have small air-spaces. Thus the strength of the individual fibres will be good.

(2) A large number of fibres per leaf. This will mean that the fibres will be fine, or that the yield will be high.

angustifolia and *A. cantala*. Only the peripheral mechanical fibres are included, since the commercial fineness of the fibre depends on these, and not on the less numerous ribbon fibres. The fineness, in this determination, refers to the average cross-sectional area of the fibres in basal leaf-sections, in hundredths of a square millimetre.

The relationship between leaf-length

PLATE II



Cross section of vascular strand from *A. sisalana*

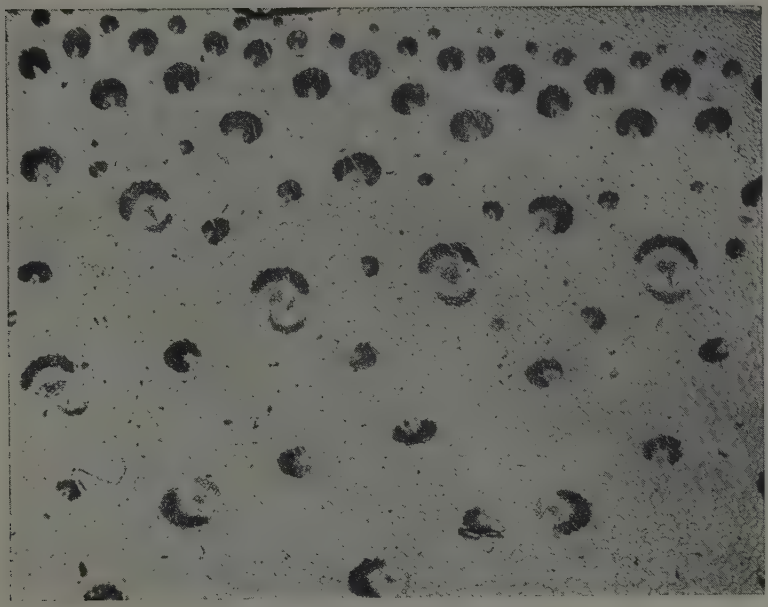
(3) Small mechanical fibres, since the fineness of a commercially prepared fibre is dependent on these.

The Relation between Length of Leaf and Fineness of Fibre.

Fig. 5 represents, graphically, the fineness of the fibre in leaves of different length of *A. sisalana*, *A. amaniensis*, *A.* and fibre-size can be represented by a straight line for all species. Since some of the plants were grown at Amani, and some on the plains, the effect of environment on fibre-size is shown. It is not very great.

These figures are of some practical interest. In view of the uncertainty as to

PLATE III



A. amaniensis

A. sisalana

The peripheral bundles of Sisal and Blue Sisal

the real requirements of the spinners, certain planters have followed the practice of cutting their plants while the leaves are still short, or of deliberately planting sisal on areas where the conditions gave rise to a short leaf, with the intention of producing a fine fibre, at the sacrifice of length. The graph shows that such a practice will have but little of the desired effect.

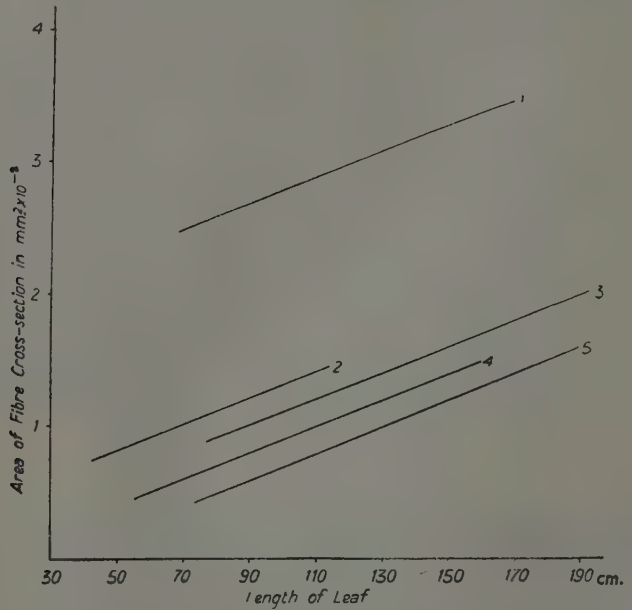


FIG. 5. Relation between leaf-length and fibre-size Agaves.
1. *A. sisalana* grown in hills. 2. *A. angustifolia* grown in hills.
3. *A. amanienis* grown in hills. 4. *A. cantala* grown on plains.
5. *A. amaniensis* grown on plains.

The average length of leaf produced on a well-managed commercial estate rarely exceeds 105 cm. This will produce fibres of average cross-sectional area of 2.9×10^{-2} sq. mm. Assuming that an endeavour is being made to produce short leaf, it is improbable that the length would average less than 80 cm. or the fibre would be condemned on the ground of shortness. This length will produce fibre of area 2.6×10^{-2} sq. mm.: a reduction of 10 per cent by area or a decrease in diameter of only 5 per cent. Precise measurements would be necessary to recognize such a slight increase in fineness, whilst the shortness of the fibre would probably result in unfavourable comment.

If fineness is to be regarded as a desideratum, it can more readily be obtained by the use of other *Agave* species which will produce fibres of greater fineness with no concomitant reduction in leaf-length. *A. cantala* and *A. amaniensis* will, under all conditions, produce fibres which are markedly finer than are those of *A. sisalana*.

The Relation between Fibre-length and Fineness.

Fig. 6 illustrates the relation between fibre-length and fineness for two species, sisal and blue sisal. For technical reasons it was not possible to use the same measure of fineness as used above. The criterion of fineness used here is the weight of unit length of fibre. The difference between the two species is diminished by this method of measurement. Weight per unit length will only give a true picture of dimensional fineness when the densities of the two fibres are equal. But blue sisal is a denser fibre than sisal, and hence the difference in fineness, if converted to a dimensional basis, would be greater than is shown on the graph.

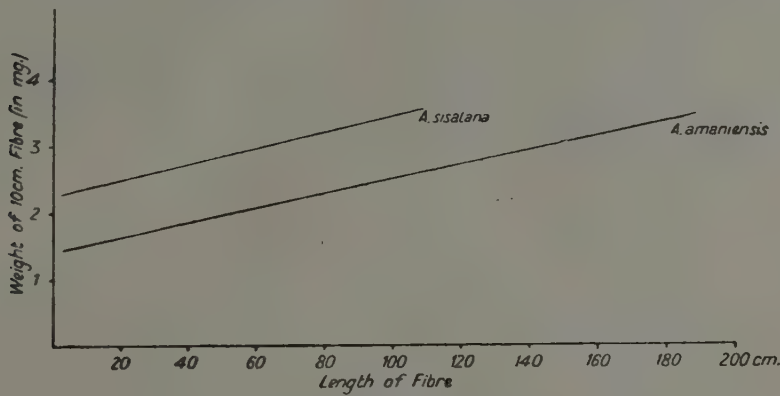


Fig. 6. Relations between length and fineness of fibre for *A. sisalana* and *A. amamiensis*

It is to be noted that the regressions of fibre-length on fineness are linear and parallel, the fibres of blue sisal being finer than those of sisal for all values of fibre-length commercially practicable.

An important point is that the *difference* in fineness of the two species is constant. That is, the ratio of comparative fineness decreases with increasing leaf length. A 20-cm. fibre of blue sisal is approximately twice as fine as a fibre of sisal of that length, whereas a 100-cm. fibre is only about 1½ times as fine. This is not of such commercial importance as might be supposed, since the long fibres are almost entirely of the ribbon type, which splits longitudinally during manufacture, and hence does not affect appreciably the fineness of the commercial product. It is otherwise with the fibres of medium length: they do not split at all, or but rarely, and their fineness determines the commercial fineness of the whole.

Distribution of Fibre by Length in *Agave* Leaves.

In any leaf, of any length, there are fibres of different lengths. Their range is, actually, from zero to the whole length of the leaf. In Tables 1 and 2 a series of leaf-lengths is arranged along the top. In the columns under each leaf-length are given the percentages of the total fibre of that leaf falling within the fibre-length-classes as given to the left of the table. Thus, supposing that we want to determine the percentage of fibre between 50 and 60 cm. long contained in a leaf of 90 cm. long, we first look in the column

headed 90. In that column, in the row opposite to 50-60 we find 25. Thus the proportion of fibre between 50 and 60 cm. long in a 90 cm. leaf is 25 per cent of the total fibre.

In Fig. 7 these results are presented somewhat differently in the form of a graph. It also includes a curve for sisal after decortication by raspador, and the effect of decortication can be seen. This figure can best be understood by considering an example. Suppose that we want to find the percentage of fibres below 50 cm. the points where this cuts the curves, we draw horizontal lines, the answer to our problems being given by the points where our horizontal lines cut the vertical axis of our graph. In this instance the answers will be:—

(1) There is nearly 10 per cent of fibres shorter than 50 cm. in a sisal leaf of 120 cm. long.

(2) There is only about 3 per cent of fibres shorter than 50 cm. in the product remaining after the decortication of such a leaf.

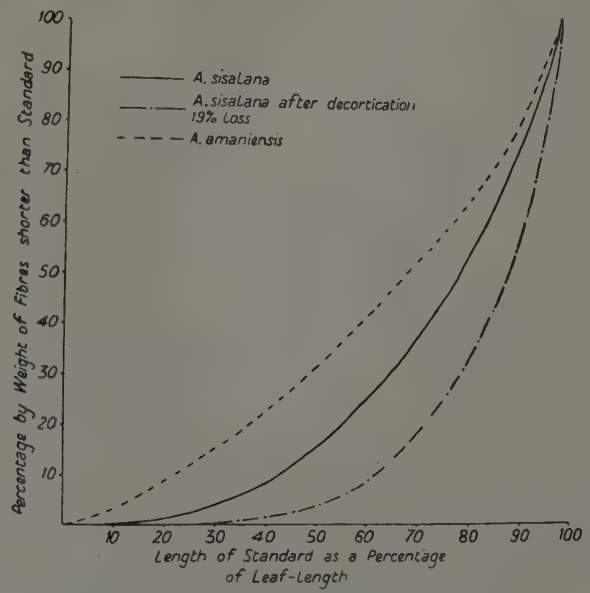


FIG. 7. Relation between leaf-length and percentage of sub-standard fibre

long in (1) a sisal leaf 120 cm. long, (2) a sisal leaf 120 cm. long after decortication, and (3) a blue sisal leaf 120 cm. long. We proceed as follows: The standard (50 cm.) is calculated as a percentage of our leaf-length (120 cm.). This figure is about 42 per cent. We then draw a vertical line from the point on the base-line of the figure corresponding to 42 per cent. From

(3) There is about 23 per cent of fibres less than 50 cm. long in a blue sisal leaf of 120 cm. in length.

THE NUMBER AND TYPES OF FIBRES IN A LEAF.

This has been studied on sections of the basal end of the leaf. Counts can readily be made at a magnification of about five

TABLE 1

DISTRIBUTION OF FIBRES BY LENGTH IN SISAL LEAVES

Length of Fibre	*Length of Leaf in* cm.											
	50	*60*	*70*	*80*	*90*	*100*	*110*	*120*	*130*	*140*	*150*	*160*
c.m.												
0–10	1	1	1									
10–20	7	4	3	2	1	1	1					
20–30	16	10	7	5	4	3	2	2	1	1	1	
30–40	27	17	11	8	6	5	3	3	3	2	2	1
40–50	49	25	16	12	9	7	5	4	3	3	2	2
50–60	..	43	25	15	11	9	8	6	5	4	3	3
60–70	..	..	37	25	16	11	9	7	6	5	5	4
70–80	..	..	..	33	23	15	11	10	8	6	5	5
80–90	..	..	..	..	30	22	15	11	9	8	7	6
90–100	..	..	..	..	..	27	22	15	10	9	7	6
100–110	..	..	..	..	..	..	24	20	15	11	8	7
110–120	..	..	..	..	..	..	..	22	19	15	11	8
120–130	..	..	..	..	..	..	..	..	21	17	15	11
130–140	..	..	..	..	..	..	..	..	..	19	16	13
140–150	..	..	..	..	..	..	..	..	..	..	18	17
150–160	..	..	..	..	..	..	..	..	..	..	..	17

TABLE 2

DISTRIBUTION OF FIBRES BY LENGTH IN BLUE SISAL LEAVES

Length of Fibre	*Length of Leaf in* cm.													
	70	*80*	*90*	*100*	*110*	*120*	*130*	*140*	*150*	*160*	*170*	*180*	*190*	*200*
cm.														
0–10	5	4	3	3	3	2	2	2	2	1	1	1	1	1
10–20	8	7	7	5	5	4	4	3	3	3	2	2	2	2
20–30	11	9	8	7	6	5	5	4	4	4	3	3	3	3
30–40	14	10	8	7	6	6	5	5	4	4	4	3	3	3
40–50	15	13	10	8	7	6	6	5	5	4	4	3	3	3
50–60	18	14	12	9	8	7	6	6	5	4	4	4	4	3
60–70	29	16	12	11	9	8	7	6	5	5	4	4	4	4
70–80	..	27	15	12	10	9	7	7	6	5	5	5	4	4
80–90	..	..	25	13	11	10	8	7	6	6	5	5	4	4
90–100	..	..	..	24	13	10	9	8	7	6	6	5	5	4
100–110	..	..	..	..	22	13	10	8	7	7	6	6	5	4
110–120	..	..	..	..	..	20	12	10	9	7	7	6	5	5
120–130	..	..	..	..	..	..	19	11	9	8	7	6	6	5
130–140	..	..	..	..	..	..	..	18	11	9	8	7	6	5
140–150	..	..	..	..	..	..	..	..	17	11	8	7	6	6
150–160	..	..	..	..	..	..	..	..	..	16	10	8	7	6
160–170	..	..	..	..	..	..	..	..	..	..	16	10	8	7
170–180	..	..	..	..	..	..	..	..	..	..	..	15	10	7
180–190	..	..	..	..	..	..	..	..	..	..	..	..	14	10
190–200	..	..	..	..	..	..	..	..	..	..	..	..	..	14

TABLE 3

Number and Type of Fibres in Sisal Leaves. (Random Selection of Leaves from Three Localities)

Length of leaf	*M*	R_1	R_2	*RT*	*T*	*T/M*	*M/RT*
cm.							
73	657	38	82	120	777	1·15	5·5
110	898	45	120	165	1,063	1·16	5·5
118	801	48	92	140	941	1·17	5·7
146	968	52	160	212	1,180	1·22	4·6
98	766	40	78	118	884	1·15	6·5
122	854	50	83	133	987	1·15	6·4
122	822	52	123	175	997	1·21	4·7
123	985	49	159	208	1,193	1·21	4·8
100	655	41	89	130	758	1·16	5·1
86	366	47	72	119	485	1·32	3·1
90	822	45	90	135	957	1·16	6·1
90	685	45	64	109	794	1·16	6·3
90	726	49	76	125	851	1·17	5·8

TABLE 4

Number and Type of Fibres in Sisal Leaves from One Plant

	Length of leaf	*M*	R_1	R_2	*RT*	*T*	*T/M*	*M/RT*
	cm.							
1	102	1,077	44	149	193	1,270	1·18	5·6
2	116	1,100	53	139	192	1,282	1·16	5·7
3	122	1,118	45	138	183	1,301	1·16	6·1
4	124	1,089	45	124	169	1,258	1·15	6·4
5	127	1,127	46	130	176	1,312	1·16	6·4
6	132	1,135	48	132	180	1,315	1·16	6·3
7	139	1,200	51	136	187	1,389	1·16	6·4
8	146	1,220	48	141	189	1,409	1·15	6·4
9	150	1,242	48	126	174	1,414	1·14	7·1
10	154	1,127	47	129	176	1,303	1·16	6·4
11	154	1,177	45	103	148	1,312	1·12	7·9
12	151	1,154	47	126	173	1,327	1·15	6·7
13	147	1,048	47	143	190	1,238	1·19	5·5
14	143	1,052	51	138	189	1,241	1·18	5·5
	136	1,133	47·5	132·4	180	1,312	1·16	6·3

TABLE 5

Number and Type of Fibres from Random Leaves of A. amaniensis

Length of leaf	*M*	R_1	*R*	*RT*	*T*	*T/M*	*M/RT*
cm.							
96	863	32	54	86	949	1·1	10·1
118	1,584	44	81	125	1,709	1·08	12·6
103	1,128	38	58	96	1,224	1·08	12·9
173	2,067	53	147	200	2,267	1·05	10·4

diameters; the mounted section is placed in the negative carrier of a vertical photographic enlarger, and the fibres can then be classified with ease. Classification has been done as follows: All mechanical fibres of the leaf are dealt with first. *M*, the result, is the total number of these fibres in the leaf. The ribbon fibres are classified into R_1, the fibres in the median line of the leaf, and R_2, those scattered throughout the ground tissues. *RT* is the total number of the protective fibres. From this is calculated the ratios T/M and M/RT. These figures express the relative amounts of the two main types in the leaf.

The following tables present some results. The first is of a random selection of *A. sisalana* leaves of various lengths. The second is of a series of leaves from a single plant of the same species, ranging from the lowest leaf on the plant to a young leaf just unfolding from the central bud. The third gives the fibre numbers for leaves of *A. amaniensis*. They are few in number, since it is extremely difficult to obtain satisfactory sections of this species, owing to the large number of fine peripheral fibres. It is worth noting that in one leaf of this species, decorticated by hand, a total of 4,524 fibres was counted.

These figures show that there is no close correlation between leaf-length and the number of fibres, whether the leaves are derived from a number of plants or whether they are all taken from the same plant, although, in general, the longer leaves tend to contain, as might be expected, the larger number of fibres. The relation between the types of a bundle in a leaf is surprisingly constant for both species, and affords a ready method of distinguishing between varieties.

The leaf of *A. amaniensis* contains many more fibres than does that of *A. sisalana*, and the proportion of mechanical to ribbon fibres is twice as great in the former. This is of considerable technical importance, as the fibre has quite a different intrinsic make-up, and it seems likely that this difference would have an effect on spinning behaviour.

The Vegetative and Nitrogen Efficiency of the Cotton Plant in Uganda

By H. R. HOSKING, *B.Sc. (Lond.), A.R.C.S., A.I.C.T.A., Asst. Botanist, Department of Agriculture, Uganda Protectorate.*

During the 1935-36 season a comprehensive trial on cotton was conducted at the Serere Experiment Station in Uganda. The treatments consisted of six varieties combined with four sowing dates and three spacings. The whole trial consisted of 288 sub-plots.

In order to find a truer estimate of the intensity of black arm disease per plant it occurred to the writer that the weight of vegetable matter per plot uprooted at the end of the season could be utilized to give a figure representing the number of black arm lesions per pound of plant material. The latter, of course, only included the aerial portions of the plants which were cut off at ground level. To ensure uniformity the weighings of fresh vegetable matter were made in the field plot by plot, as soon as the "uprooting" of each plot was completed.

It was further decided to utilize this weight of plant material to determine what is here known as the "vegetative efficiency" of the cotton plant, i.e. the "vegetative efficiency" represents the number of pounds of seed cotton produced by each pound of fresh vegetable matter (excluding roots).

At the start the figure of 7,693.3 lb. of vegetable matter per acre was so startling that several interesting lines of thought arose which will be discussed later in this paper.

The yields of seed cotton per acre and of fresh vegetable matter per acre for each of the "treatments", together with the "vegetative efficiency", are shown in Table 1.

It will be seen that the vegetative efficiency decreases as the planting date advances. This result was entirely unexpected from cursory observations made over eight seasons. The lower vegetative efficiency of the closest spacing was also another unexpected result.

The variety S.G. 29 is the standard in the country surrounding Serere. It is derived from Nyasaland Upland. The habit is bad, as the general tendency is to run to wood. The monopodia are long and weak, and lie along the ground. Many of the sympodia in the central section of the main stem are frequently suppressed by black arm disease.

S.P. 72 was originally selected from Nyasaland Upland (N. 17) for resistance to black arm. This is a woody type but its habit is a little superior to S.G. 29, and of course, owing to its higher resistance to black arm, suppression of sympodia seldom occurs.

The remaining varieties, S.P. 20, S.P. 43, S.P. 48, and S.P. 56, arose as re-selections from Parnell's U.4.4.2. The first three are closely related and came from one of the original selections S.P. 13. S.P. 56, on the other hand, comes from another of the original selections S.P. 14, and is different in plant habit, quality of lint and response to disease. Agriculturally, it is not such a desirable type as the S.P. 13 derivatives, but has rather better lint.

The comparison of the vegetative efficiency of these six strains followed expectation except that S.P. 56 gave the surprisingly poor index of 0.080, as com-

pared with S.G. 29's 0.112. S.P. 72 showed itself an improvement on S.G. 29; while the small sympodia strains, S.P. 20, S.P. 43 and S.P. 48, registered the highest vegetative efficiency.

It should be stated here that the 1935-36 season was unusual. The yields of seed cotton per acre were the highest yet recorded at Serere. Furthermore the latter part of the dry season was extraordinarily wet, and resulted in abnormal secondary growth. At the time of "uprooting" (see below) the plants were covered with small green leaves, a considerable number of diseased green bolls and a high proportion of flowers. A sample was taken of the variety S.G. 29 and gave the following percentage proportions by weight of the different aerial parts:—

Stem and branches ...	50%
Leaves	50%
Bolls and flowers ...	20%
Total plant material ...	100%

TABLE 1

Treatment	Mean yield seed cotton lb./acre	Mean yield fresh vegetable matter lb./acre	Vegetative efficiency
Varieties—			
S.G.29 ..	705·7	6,316·0	0·112
S.P.72 ..	948·8	7,571·8	0·125
S.P.20 ..	1,107·1	6,963·7	0·159
S.P.43 ..	1,097·1	7,043·4	0·156
S.P.48 ..	1,134·5	6,307·8	0·180
S.P.56 ..	805·9	10,097·8	0·080
Least significant difference ..	147·3	..	..
Spacings—			
3ft. x ½ft. ..	961·0	8,639·4	0·111
3ft. x ¼ft. ..	977·5	7,380·1	0·132
3ft. x 1½ft. ..	960·9	7,043·4	0·136
Least significant difference ..	None	..	..
Sowing Dates—			
First (May 1st)	1,156·1	6,289·2	0·184
Second (May 31st) ..	1,119·5	8,295·5	0·135
Third (July 1st)	1,005·3	8,333·9	0·121
Fourth (Aug. 1st) ..	585·1	6,248·9	0·094
Least significant difference ..	479·8	..	..
Means of whole experiment ..	966·5	7,693·3	0·126

In Uganda all plants have to be "uprooted" and burnt at the close of the picking season. In practice, "uprooting" is a misnomer, since the native cultivator merely cuts off the plants at ground-level with a hand hoe. The plants are then heaped up, usually on anthills, and burnt

when sufficiently dry. This practice doubtless helps very materially to control a variety of insect pests. If, however, one considers that in the experiment under review 966.5 lb. of seed cotton per acre was taken off the soil and in addition to this 7,693.3 lb. per acre of fresh plant material was burnt, one at once realizes that a heavy crop of cotton results in a tremendous drain on the soil fertility. The lint is lost to Uganda, while much of the seed is also exported.

If the total nitrogen content of the plant material and the seed cotton be compared, it is found that the former accounts for by far the greater annual drain on the nitrogen content of the soil.

Lacking results of chemical analyses of local cottons, let us accept (as have Howard and Wad in *The Waste Products of Agriculture*, 1931) the figures given by Anderson and Ross (1899).[1]

It will be seen that twice as much nitrogen per acre is destroyed by burning the "uprooted" cotton as is lost by exporting the whole of the seed and lint.

In addition to the vegetative efficiency of any cotton variety it should be possible to estimate the nitrogen efficiency, or the efficiency in terms of any of the other important plant nutrients. For example, if we accept for the moment, lacking accurate figures under Uganda conditions, the total nitrogen per acre contained in the aerial portions and seed cotton of the variety S.G. 29 as given in Tables 2 and 3, and divide this into the pounds of seed cotton produced, we obtain the amount of seed cotton produced by each pound of nitrogen.

TABLE 2.—VARIETY S.G.29—VEGETATIVE PARTS

	Actual weight per acre lb.	Percentage Nitrogen* in dry material	Approx. percentage in weight on drying	Weight of Nitrogen per acre lb.	Total Nitrogen lost through destroying the vegetative parts of the plant
Stem	3,158·0	0·64	30	14·15	
Leaves	1,894·8	2·25	90	4·26	27.66 lb. per acre
Bolls	1,263·2	1·83	60	9·26	

TABLE 3—VARIETY S.G.29—SEED COTTON

	Actual weight per acre lb.	Percentage Nitrogen* in dry material	Approx. percentage in weight on drying	Weight of Nitrogen per acre lb.	Total Nitrogen lost by exporting all the lint and seed
Lint	215·2	0·18	5	0·37	14.26 lb. per acre
Seed	490·5	3·54	20	13·89	

*Anderson and Ross.

[1] Anderson, J. T., Ross, B. B., *et al*: "The Cotton Plant Considered in Some of its Chemical Relations," Alabama Agr. Exp. Sta. Bull. 107, 1899.

Applying the same data to the other varieties we obtain the nitrogen efficiencies shown in Table 4.

TABLE 4

Variety	Nitrogen Efficiency	Nitrogen Efficiency as percentage of that of S.G.29
S.G.29	17	100
S.P.72	18	106
S.P.20	21	124
S.P.43	21	124
S.P.48	23	135
S.P.56	13	76

While it is admitted that these figures are not accurate, it is probable that the relative nitrogen efficiencies expressed as percentages of S.G. 29's efficiency are fairly accurate. It will be seen then that the related strains S.P. 20, S.P. 43 and S.P. 48 use up considerably less nitrogen when producing a unit of seed cotton than do the two Nyasaland strains S.G. 29 and S.P. 72, or the U.4.4.2 derivative S.P. 56. The last variety is extremely inefficient; or, in other words, owing to its excessively vegetative habit, it causes a far larger drain on the soil for the same yield than do any of the other varieties.

H. B. Brown, in *Cotton*, published in 1927 in New York, gives the table quoted below of "Weight of plants and plant nutrients in plants which produce a bale of seed cotton": —

Brown's plants produced 1,590 lb. of seed cotton and 2,728 lb. of vegetable matter (excluding roots). Therefore the vegetative efficiency is 1.72. This is considerably lower than any of the Serere figures, where the yield per acre of seed cotton is equivalent to less than half a bale (500 lb.) of lint. The aerial vegetative parts contained 34.11 lb. of nitrogen to the 39.48 lb. in the seed cotton. The nitrogen efficiency is therefore 0.046. The latter figure is comparable with the theoretical nitrogen efficiencies of the varieties S.P. 20, S.P. 43 and S.P. 48.

Brown states that an examination of Table 5 "will convince anyone that the draft (drain of plant nutrients) is comparatively light. All of the cotton plant is returned to the soil except the seed and the lint." This is very different from the state of affairs in Uganda.

The question of the depletion of soil fertility is one which is of paramount importance to this country. Under existing conditions no organic matter is deliberately returned to the soil by the native cultivators. They depend on bush fallows to revive their soil. Therefore it is suggested that if the long view is to be taken both the vegetative and nitrogen effi-

TABLE 5

Part	Percentage of weight	Weight in pounds	Pounds of Nitrogen	Total Nitrogen per bale (500 lb. of lint)
Root ..	8·80	417	2·00	2·00 lb.
Stems ..	23·15	1,096	7·01	34.11 lb.
Leaves ..	20·25	959	21·58	
Burs ..	14·21	673	5·52	
Seed ..	23·03	1,090	38·58	39.48 lb.
Lint ..	10·56	500	0·90	
Totals..	100·00	4,735	75·59	75·59 lb.

ciency of any strain of cotton are of importance. It should be noted that the yield of seed cotton is not always correlated with vegetative and nitrogen efficiency (compare S.G. 29 and S.P. 56). The soils in the Eastern and Northern Provinces of Uganda have naturally low organic contents. Before the land is cultivated little erosion occurs, but as soon as the land is opened up the structure deteriorates very rapidly and soil erosion can then become a major problem. It is probable that the loss of soil structure is intimately associated with loss of organic matter, and that this organic matter is lost through the agencies of leaching and oxidation and the requirements of the crops grown. The organic content (and hence structure) of unbroken land is probably in a state of equilibrium. On opening up this land and growing crops it may be found that a very small drain on the natural organic matter results in rapid deterioration.

It is suggested that a closer investigation into the vegetative and nitrogen efficiency of cotton might give valuable data in respect to soil deterioration (deterioration of structure and loss of organic matter followed by erosion). As a preliminary experiment the writer is putting down four plots as a permanent trial. Each plot is to grow cotton annually until such time as it will bear no more. The treatments are: —

(*a*) Uprooting and burning as in the normal native practice, the ash not being returned.

(*b*) As above, except that the ash is returned to the plot.

(*c*) All uprooted plants dug into the plot at once.[1]

(*d*) The uprooted plants clamped in a pit elsewhere and returned to the plot when they have decomposed sufficiently.

If soil samples for "aggregate analyses" and organic carbon deteriorations are taken at the commencement and during the course of the experiment, we should be in a better position to estimate the effect exerted by cotton on soil fertility and on soil structure.

[1] An experiment conducted by the Mycologist (Mr. C. G. Hansford), at Serere, demonstrated that this practice does not result in any increase of black arm attack in the subsequent cotton crops.

Ecological Methods in the Study of Native Agriculture

Native agricultural methods are worthy of careful study by the administrator in tropical Africa. To the European these methods may appear primitive and however, often difficult to discover the inefficient; but an examination may show that sound reason underlies them. It is, however, often difficult to discover the underlying reason; and in consequence the studies of an ecologist, trained in relating climate, soil types and vegetation, may be expected to contribute much to our knowledge.

For this reason the activities of the Ecological Survey of Northern Rhodesia deserve to be watched closely by all who are concerned with native agricultural development. In an important paper,[1] Mr. C. G. Trapnell has summarized the results to date of the survey for which he has been primarily responsible. The survey was inaugurated in 1931 with the objects of determining and mapping the types of country in terms of their vegetation cover, the study of existing agriculture and the natural products found within these types of country, and in particular the provision of a basis for native agricultural development.

There was no precedent for a large-scale survey of this type, and the principles of its working had to be found rather than applied. In an initial detailed survey of 13,000 square miles in the lower Kafue basin the hypothesis of a direct correlation of vegetation type with agricultural practice and potentialities was tested and found of general validity. A correlation of vegetation with soil type and fertility, as analytically determined, was also to have been tested, but analytical work ceased on the retrenchment of the Soil Chemist at a point when promising results were being obtained. Field observations on soil derivation and profile were, however, maintained, and led Trapnell to recognize six main soil groups. These soils carry their characteristic vegetation; and, on the basis of the soil-vegetation relationship, he has devised mapping units that are significant for agricultural purposes.

" A method of survey in which vegetation is given primary importance in the differentation of type of country makes for the greatest ease and rapidity of mapping. It allows of the use of native information, for the native can define the forests where he cannot define the soil; he can also supply much information in advance of a traverse which will greatly facilitate sampling. But most important for present purposes is the fact that a modified vegetational method provides a land classification which is immediately applicable to native agricultural practice.

" The reason for this lies in the native's method of land selection. Certain trees and grasses, or a certain type of bush, are recognized, normally intuitively and without conscious thought, as indicating good land for the staple crop or for the various types of garden made. Selection for soil fertility is general, but there are exceptions to this among certain forest tribes who rely for fertility on the ash of the trees which they fell to make their gardens and who may haul in brushwood from an area much larger than that cultivated in order to obtain the requisite supply. This primitive stage persists among the Kaonde and allied tribes of the

[1] *Ecological Methods in the Study of Native Agriculture in Northern Rhodesia,* C. G. Trapnell; Bulletin of Miscellaneous Information No. 1, 1937, Royal Botanic Gardens, Kew.

Northern Plateau region. Their tradition, and possibly a general deficiency in the soil, requires heavy fertilizing with wood ash, and they have remained content with the selection of stands of timber convenient for cutting, commonly using poor forest soil on poorer soil than they could obtain. A stage once removed from that of the Kaonde is found in certain tribes of the Lunda-Luvale group on the Kalahari sands of north Barotseland. Climax forest of certain trees, notably *Cryptosepalum pseudotaxus*, is selected, primarily because the tree gives a dense brushwood for ash for bulrush millet cultivation, but also because climax forest soil is recognized as good. The advanced Luchaze, referred to later, indicate this by saying that they choose *Cryptosepalum* forest with the moss *Leucobryon dimorphodictyon* which covers the forest floor in the climax phase.

"A more definite use of trees and grasses as indicators of soil fertility is found among tribes outside these two groups. The fertilizing effect of ash is treated as incidental to the making of the bush garden, or, as amongst the Lenje and Tonga on the Southern Plateau soils, deliberate ash fertilizing is retained for certain crops which require it. Apart from this, the main and subsidiary gardens are selected for soil fertility. The most important indicators are various species of *Acacia*, notably *A. cambylacantha* among the Ila and Tonga of the upper valley region, and of the grass *Hyparrhenia*, such as *H. Rubrechtii*. While the sites are recognized intuitively, the indicator will be readily named in response to questioning and the same answer will be given in village after village. Regard is also had to soil colour, but not to this alone. Among the Ila-Tonga group indicators of both good and bad soil begin to be recognized and the crop for which the soil under a particular type of bush is suitable, the period for which it can be worked and even the phase in the succession at which it can be returned to are known. Finally, the most advanced stage is represented by the methods of the Luyi or Rozi group of tribes in and about the central Barotse Plain in the Kalahari region. These people have a highly developed system of small gardens in grassland, and the various sites and combinations of these gardens are determined by a series of indicator grasses which have come to be used not only consciously but also traditionally for the recognition of sites.

"A full discussion of this 'Luyi code' of land selection would require a separate paper, but it may be used as an extreme example of the fact that native principles of land selection cannot be understood without ecological study of the country. The sites are placed in grassland which varies in composition as the soils range between acid sand, seepage peat, basic clay loam and swamp peat. Through these grasslands are distributed raised wet season gardens and sunk dry season gardens for maize and kaffir corn, drained seepage gardens for winter maize, taro and other characteristic crops, subsoiled sweet potatoes and cassava gardens, etc. There is an appearance of complete confusion of method until the various garden types are worked out in relation to the zonation of the grasslands and the soil and moisture variations which they indicate. Without further instances it can be said that in north-western Rhodesia the native's land selection and therefore the types of garden which he makes, cannot be fully understood until his sites are studied and discussed with him from an ecological standpoint."

The author surveys the native agricultural systems of Northern Rhodesia: —

"With this precision of land selection is associated an admirable adaptation of

agricultural systems to their environment, as constituted by the type of soil and forest occupied. This applies particularly to the distribution of staple crops and to the broad lines of agricultural practice. Agricultural practice is, of course, largely determined by tradition, but tradition itself reflects past environment, and when a tribe has been long settled in its country its tradition complies with its requirements. It has thus been found that, except in cases of recent immigration, the extent of a given agricultural system can be defined by a vegetation-soil unit."

The paper concludes with a section on the progress of native agriculture, which may be quoted in full:—

" The parallel study of vegetation-soil units and of native agricultural systems allows of a comparative treatment of these systems from which their degree of development may be estimated, and means found for their improvement upon native lines. This requires some explanation. Progress in native agriculture, where it takes place naturally, is an important point unlike the progress of European communities. Normally it attempts no defeat of environment by the increasing use of fertilizer and other extraneous aids. Adhering to its primitive implements it follows the less ambitious but effective course of an increasingly thorough use of environment. Differences in development of this type are to be found between and within the systems previously quoted. These differences are best summarized as given in the report of the Survey for 1934: ' Certain tribes or sections of tribes fall short of the rest in the degree of development of their system. They may lack either the precision of land selection, the variety of gardens and crops, or the efficiency of cultural methods of their more advanced neighbours. Commonly their apparently backward methods are the outcome of limitations imposed on them by their environment, and cannot for that reason be improved. But they may equally be conditioned by an inferior mentality and lack of initiative, a low standard of living, lack of contact with other tribes or conservative adherence to an outworn tradition.'

" Improvement is taking place naturally where, as in Barotseland, an advanced tribe has suzerainty, and, at the same time, a great intermingling of tribes has taken place. Marose chiefs have encouraged the spread of the Luyi system, and there has been an exchange of methods and crops and a levelling up of the standard of living. In other cases measures for the accomplishment of this have been suggested by the Survey in the report for 1934 referred to previously.

" The possibilities of progress of this type, namely upon native lines, are best investigated upon the basis of comparative ecological survey, because it allows of the adoption for trial of the practices of neighbouring peoples and thus involves the minimum of agricultural experiment. A similar if less obvious application of ecological methods is possible in cases where native agriculture has been adversely affected by contact with Europeans. These changes tend to be retrogressive rather than progressive. The native's knowledge of his environment is forgotten, his traditional system forsaken for a parody of European methods, and large-scale shifting cultivation of crops for the market leads to land shortage, deforestation and erosion. This state of affairs in reserves adjoining the railway line is alluded to in the report of the Survey for 1933. The processes of change are best worked out by an ecological-agricultural survey, for departure from traditional methods of land selection as well as of agricultural practice are in-

volved. There is, for example, a general tendency to move from Southern Plateau and Transitional sites into thorn belts, particularly of the *Acacia Woodii* type which provides the best European farming land, the object being to secure large areas of easily stumped fertile land. Both these stages and the corresponding stages in departure from the traditional agricultural system have to be recognized before the process can be understood, and remedial measures may have to combine European practices for maintaining fertility with a modified form of the native's tradition.

" So long as traditional native practice is involved, an ecological basis is necessary for agricultural development in native areas, for the traditional practice can only be understood through its relationship to environment. This aspect has been deliberately stressed in place of the obvious application of ecological study to questions of crop introduction, forest conservation or the prevention of erosion. The general principles underlying this aspect may be stated in conclusion. In Northern Rhodesia, if not in other East African territories, the soil is the factor of primary importance in determining vegetation types, these in turn guide the native's land selection, and upon his land selection is based the form of his agricultural tradition. For the understanding of that tradition, the accomplishment of progress in it or the remedying of departure from it, it is necessary to look at the soil, and to look at it in the manner of the native, namely through the indications given by the vegetation."

The paper is illustrated by black-and-white maps of main rainfall zones, soil regions, main tribal groups, and native agricultural systems, and also by a coloured map of main vegetation-soil units.

A Description of a Highly Fatal Virus Disease of Poultry new to East Africa

By J. R. HUDSON, *B.Sc., M.R.C.V.S., Veterinary Research Laboratory, Kabete, Kenya Colony.*

In the Annual Report of the Director of Agriculture of Kenya for 1935 brief reference to an outbreak of a disease of fowls, clinically and pathologically resembling Newcastle disease, was made. The disease was diagnosed in November of that year in birds forwarded to Kabete from Mombasa. The European owner of the fowls reported that in the preceding twelve months there had been an extensive outbreak of the disease on Mombasa Island, and that very large numbers of birds had died.

The recent discovery of an outbreak of the same disease in the Eastleigh district of Nairobi has made it desirable that a full description of the condition be published, so that all poultry owners may be on the watch for it.

SYMPTOMS.

As in most other diseases of poultry, the first symptoms noticed are dullness and a reduction in appetite. It is not long, however, before the very characteristic symptoms resulting from irritation and a marked increase in the secretions of the mucous membranes of the head and neck appear. The bird stands with its eyes closed, and, as it breathes in, the beak is opened and the neck is extended, lifting the head to its highest point. During expiration the neck retracts and the head is drawn down to the body. An excess of mucus accumulates around the nostrils, the corners of the beak and the eyes. In the majority of cases, mucus is cleared from the throat at intervals by coughing, and if the bird is confined in a small box or coop, the walls will be found splashed with coughed-up exudate.

As the condition progresses, weakness of the legs develops, and, as the hocks become more and more flexed, the fowl crouches lower and lower. If disturbed, the bird may move a step or two; but it rapidly reassumes its original crouching position. At this stage the peculiar extension and retraction of the neck stops, and the bird then remains with the head drawn in and eyes closed, as if asleep. An occasional cough may still be heard.

The final stage is marked by inability to remain on the feet. The fowl lies almost on its side, with the legs straight out, pointing half backwards. This stage may last for twenty-four hours or more, and during this period, the temperature, which in the early stages may rise considerably above the normal (about 107° F. in the fowl), becomes markedly subnormal.

Diarrhoea is not a common symptom, but does sometimes occur.

The duration of the symptoms varies very considerably in different subjects, in some being as short as twenty-four hours and in others as long as four or five days. Two experimental birds have appeared to recover temporarily, only to die after a fortnight.

POST-MORTEM LESIONS.

The lesions found on post-mortem examination of cases of the disease depend to a large extent on the rapidity with which death has occurred.

In the acute type of case, the lesions consist of small hæmorrhages. When the abdominal cavity is opened, these may

be seen scattered on the gizzard fat and on the internal surface of the sternum. The most characteristic sites are, however, in the glandular stomach and gizzard. In the former, the hæmorrhages often unite to form a network surrounding the openings of the glands. In the latter organ, if the tough lining membrane is stripped, diffuse, thin and rather pale hæmorrhagic patches are seen. Very numerous, fine hæmorrhages may be found in the intestines, but these are not of great importance in diagnosis, as they occur in a wide variety of conditions.

Hæmorrhages may also be found on the outside of the heart and in the liver. The upper larynx almost always shows a hæmorrhagic lesion which even in acute cases shows some tendency to ulcerate.

In the more prolonged cases the tendency to hæmorrhage is generally less marked and no hæmorrhages may be found on the heart, abdominal fat or in the gizzard or intestines. In almost all cases, however, some degree of submucous hæmorrhage will be found in the glandular stomach, along either the anterior or posterior margin of the glandular portion. In the less acute cases the lesion in the larynx is more developed and more necrosis and ulceration are present. The larynx may contain a loose plug of yellow, cheesy material, or a mass of adherent necrotic tissue may be found on its floor. The mucous membrane of the larynx appears raw and ulcerated, and in the upper part of the windpipe the strongly congested vessels may be seen through the mucous membrane.

If washed free from the dirty mucus covering their surfaces, the mouth, throat and the insides of the nasal passages usually show a number of fine, pitted ulcers, reminiscent of those found on the lower gum of cattle that have died of rinderpest.

Cause of the Disease.

The disease is caused by a filtrable virus which is present in great concentration in the exudate from the nose and throat, and in a less concentrated form in the blood and internal organs. The virus is highly resistant to the action of 50 per cent glycerine, and may be preserved in this medium in the ice-chest for several months.

The disease is very contagious, and clean birds are readily infected by placing them in contact with sick birds. Infection is also easily conveyed from sick to healthy stock by handling. A box which has been used for infected birds has been found to remain infective for one or two days after their removal; but infection does not remain for longer than a fortnight, even if the box is left uncleaned.

Experimentally fowls may be infected by the instillation into the throat, or by the intravenous inoculation of material containing virus from sick birds.

In its symptoms and post-mortem picture this disease agrees with the condition known in England as Newcastle disease. The characters of the virus are also very similar to those of the virus of Newcastle disease. As yet, however, no cross-immunity experiments have been made to determine if the two conditions are identical. Newcastle disease occurs in India, where it is known as Ranikhet disease, and if the Kenya disease is the same condition it is possible that it was introduced from that country.

The relationship between Newcastle disease and classical fowl plague is not yet clear. Some workers are of the opinion that they are distinct diseases, others that they are different forms of the same disease.

Mortality.

Probably the most striking character of the disease under discussion is the ex-

tremely heavy mortality. In experimental birds at Kabete this has been well over 95 per cent. In natural outbreaks of Newcastle disease in England a mortality of 100 per cent has been recorded on more than one occasion. Fully grown birds are very susceptible, but evidence is not yet available as to the susceptibility of chicks. Turkeys and guinea-fowl are also susceptible, and pigeons can be infected experimentally. There can be no doubt of the heavy economic loss that can be experienced as a result of an outbreak.

Control Measures.

Unfortunately no vaccine has been elaborated that will protect fowls, and the only hope of controlling the disease lies in the adoption of very stringent quarantine measures to guard against its introduction. Poultry owners should not allow their birds to mix with other fowls, and should take the greatest care when purchasing new stock. Any new stock should be isolated for a fortnight in order to make certain that the disease is not being introduced. Particular care should be taken in the purchase of native "broody" hens, a common practice on many poultry farms.

If an outbreak occurs on the farm, the measures to be adopted will depend on the rapidity with which the disease is detected and upon the type of husbandry practised. If an outbreak is discovered in time in an isolated run of birds, it is possible that the early slaughter of the birds in the run will prevent spread to other runs, provided that proper care is always taken in the disinfection of utensils and of the feet, hands and clothes of attendants. On farms where free range is allowed or on farms where the birds are kept in runs and the outbreak has been in existence for some time before a diagnosis is made, the slaughter of all stock is indicated. If the birds are slaughtered early, houses can be disinfected and, after the lapse of a fortnight, new stock can be introduced. If the birds are not killed, the great majority will die, and, as it will be much longer before the farm can be re-stocked, the financial loss will be greater.

It is, of course, essential that an early diagnosis be made. If the presence of the disease is suspected, settlers are advised to forward to the Veterinary Research Laboratory, Kabete, as soon as possible, one or two sick birds.

Annotated Host List of Uganda Parasitic Fungi and Plant Diseases—Part II

By C. G. HANSFORD, *M.A., F.L.S., Mycologist, Department of Agriculture, Uganda Protectorate.*

CARICACEAE.

CARICA PAPAYA (Pawpaw).

Oidium caricae Noack, mildew on leaves and flowers, on petioles and young stems. Considerable distortion of the leaves results from infection, with some disintegration as the leaves expand. On the whole, however, no serious damage is caused by the disease in Uganda, and no complaints of loss of crop have been received.

Acremoniella sp., leaf spot.

Cercospora sp. causes leaf-spots, and these are often overgrown by *Verticillium epiphytum*, parasitic on the *Cercospora*.

Glomerella cingulata (Ston.) Spaul. and Schrenk, in its *Colletotrichum* stage, causes a ripe rot of the fruit; the incidence is small.

Fusarium oxysporum Schlecht., f., causes a rot of the roots and base of the plant; eventually the trees fall over and die.

THEACEAE.

THEA SINENSIS (Tea).

Armillaria mellea (Vahl.) Fr., causes a root rot, and is the most important disease of this crop at present in Uganda. Tea is much more susceptible to attack by the disease than other plantation crops grown here, and therefore more detailed attention must be given to the preparation of the land prior to planting with tea. In general it may be stated that tea is likely to do better in Uganda on land cleared from grass or thin bush vegetation than on old forest land. All stumps and roots from the cleared bush must be totally destroyed by burning before the tea is planted, as any such left in the ground are liable to prove sources of considerable trouble at later stages. The fungus uses the stumps and roots as sources of food to enable it to grow through the soil and to attack the roots of the tea. On the latter it grows into the bark and wood, eventually reaching the main stem. Affected bushes are killed, and diagnosis of the disease is easy from the presence of small black fungus growths through cracks in the bark of stem and roots. These parts have a pronounced pleasant mushroom smell when freshly dug up. Affected bushes are easily split into sectors comprising one or more of the main branches and roots.

Fomes lamaoensis Murr., "brown root disease", much less common on tea in Uganda than *Armillaria*; affected roots are covered with a brown layer of mycelium of the fungus.

Rhizoctonia lamellifera Small, has been recorded from this host in Uganda, associated with a dieback of the branches. Its status as the prime cause of the disease has not been thoroughly worked out in Uganda.

Colletotrichum camelliae Mass., "brown blight", and

Pestalozzia theae Saw., "grey blight", have been found on tea here, but in the great majority of instances these fungi have been limited to the older leaves of the bushes, and thus have no direct effect on crop production. As far as is known, they cause little or no damage to the crop under Uganda conditions.

Nectria binotiana Sacc. (conidial stage *Verticillium candidulum*, var. *binotiana* Sacc.) has been recorded from dying tea branches, but is apparently saprophytic.

"Scabbed Leaf" Disease, apparently of non-parasitic origin, is present in Uganda on the older foliage of the bushes.

MYRTACEAE.

EUGENIA sp. (Indigenous).

Tryblidiella rufula (Spreng.) Sacc., has been found on dead branches; apparently only saprophytic.

EUCALYPTUS sp. (Blue Gum).

Armillaria mellea (Vahl.) Fr. occasionally attacks these trees, causing a root rot; the incidence appears to be small in Uganda.

Rhizoctonia lamellifera Small causes a root disease similar to that described above on *Grevillea*; the present host is rather less susceptible than *Grevillea*, though cases are common, usually limited to individual trees.

Phyllosticta sp., leaf spot.

PSIDIUM GUAJAVA (Guava).

Armillaria mellea (Vahl.) Fr., root rot, recorded by Small, but not encountered again.

Glomerella cingulata (Stonem.) Spaul. and Schrenk, ripe rot of fruit.

MELASTOMACEAE.

DISSOTIS sp. (Indigenous).

Irenina melastomacearum (Speg.) Stevens, on leaves.

Puccíniosira dissotidis Wakef., rust.

TRISTEMMA sp. (Indigenous).

Puccinia necopina Grove, rust.

COMBRETACEAE.

COMBRETUM sp. (Indigenous).

Irenina laguncularíae (Earle) Stevens,

Asterina combreti Syd., and

Meliola sp., all on leaves, forming black patches.

HYPERICACEAE.

HYPERICUM sp. (Indigenous).

Uromyces hyperici-frondosi (Schw.) Arth., rust, on *H. lalandii* and *H. peplidifolium*.

Uredo hyperici-schimperi P. Henn., on *H. lanceolatum*.

TILIACEAE.

CORCHORUS sp. (Jute).

Macrophomina phaseoli (Maubl.) Ashby, sterile stage *Rhizoctonia bataticola* (Taub.) Butl., causes a root disease, and some of the trial plots of this crop in Uganda have proved failures on account of heavy attack of this disease.

Alternaria macrospora Zimm., leaf spot, chiefly on plants attacked by the root disease above.

GREWIA sp. (Indigenous).

Asterina nyanzae Hansford, on leaves.

Phyllachora grewiae (Kalch.) Theiss and Syd., on leaves.

Uredo grewiae Pat. & Har., rust.

HONCKENYA sp. (Indigenous).

Phyllachora grewiae (Kalch.) Theiss and Syd., on leaves.

Irenopsis coronata (Speg.) Stev., var. *vanderystii* Beeli, on leaves.

TRIUMFETTA sp. (Indigenous).

Irenina sp. on leaves.

Irenopsis coronata (Speg.) Stev., var. *triumfettae* Stevens on leaves.

Uromyces sp., rust.

Helminthosporium triumfettae P. Henn., forming dark brown velvety patches on lower surface of leaves, frequently parasitized.

Cercospora triumfettae Syd., leaf spot.

Verticillium albo-atrum R. & B., wilt disease, recorded only once on this host, from which it has been cross-inoculated to cotton.

STERCULIACEAE.

ABROMA AUGUSTUM (Imported Fibre Plant).

Verticillium albo-atrum R. & B. causes a wilt disease of this host at Kampala; affected plants die back to soil level and produce new shoots from their base; these shoots become attacked in turn. Some 5 to 10 per cent of the plants grown at Kampala Plantation were attacked in 1936. Infected plants are soon invaded by *Fusarium* sp., which fruit over the surface of the dying branches.

Cercospora sp., leaf spot.

DOMBEYA sp. (Indigenous).

Phyllachora dombeyae Syd., on leaves.

THEOBROMA CACAO (Cacao).

Phytophthora palmivora Butl., causes a rot of the pods, but is not frequent in Uganda, and, as far as is known, does not cause a canker of stems and cushions as in other parts of the tropics.

Helicobasidium longisporum Wakef. forms a thin purple layer over the roots and base of the stem; it is infrequent, and its status as a parasite has not been investigated in detail.

Armillaria mellea (Vahl.) Fr., root rot, not common on this host.

Rhizoctonia lamellifera Small, occurs on the roots of cacao in Uganda, and is associated with dieback of the upper parts of infected trees; it appears improbable that the fungus is the primary cause of this dieback, which is now attributed to the climatic conditions of Uganda not being suited to this crop.

Colletotrichum theobromicolum Del., on leaves.
Phyllosticta sp., leaf spot.
The following occur on dead and dying twigs:—
Didymosphaeria sp.
Nectria flavo-lanata B. & Br., conidial stage *Cephalosporium* sp.
Calonectria rigidiuscula (B. & Br.) Sacc., conidial stage *Fusarium decemcellulare* Brick.
Septoria sp.
Phlyctaena anomala Petch.
Cephalosporium sp.
Stilbella sp.
Trichosphaeria sp.
Stachybotrys theobromae Hansford.
Botrytis sp.

MALVACEAE.

ABUTILON sp. (Indigeous).
Nematospora gossypii Ashby & Nowell, in seed from plants infested with *Dysdercus* (cotton stainers).
Puccinia abutili B. & Br., rust.
Puccinia heterospora B. & Curt., rust.
Cladosporium herbarum Lk., f., causing greenish-brown mouldy spots on lower surface of leaves.

GOSSYPIUM sp. (Cultivated Cotton).
Bacterium malvacearum EFS., angular leaf spot and black arm (*vide* account in *E. Afr. Agric. Journ.*, I, p. 131, 1935).
Nematospora gossypii Ashby & Nowell, internal boll disease, the fungus being carried from boll to boll and introduced into the lint cavities by the cotton stainer *Dysdercus* in the act of feeding. No other means of infection or distribution is known. The disease occurs everywhere in Uganda every year, though the damage varies within wide limits. The same fungus has been recovered from the interior of cotton seed.
Glomerella gossypii Edg., conidial stage *Colletotrichum gossypii* South., anthracnose. Until recent years reports of this disease being widespread over Central Africa were common, but it is now realized that most of these reports refer to black arm disease, and that the true anthracnose of cotton is comparatively rare in this area, and is of importance only in very wet weather or seasons. Affected bolls show large purple-black areas, with a dark purple margin; under moist conditions they are covered with a pinkish mass of spores. These spots are easily confused with those of *B. malvacearum*, which under similar conditions are often overgrown with *Fusarium* sp., which produce a white to pink spore layer on the surface.
Mycosphaerella areola Ehrlich & Wolf, conidial stage *Cercosporella gossypii* Speg. (*Ramularia areola* Atk.), areolate mildew; of universal occurrence in Uganda every year; it is severe only in very moist weather or on cotton growing under shade, when some defoliation may occur. Otherwise the disease has little effect on the plants. The ascus stage has not been recorded hitherto from Uganda.
Mycosphaerella gossypina (Atk.) Earle, conidial stage *Cercospora gossypina* Cke., leaf spot, of no importance.
Kuehneola gossypii Arth., rust; only one record (1917-18) is known for Uganda.
Phyllosticta gossypina Ell & Mart., leaf spot.
Ascochyta gossypii Syd., leaf spot.
Ascochyta sp., near *phaseolorum* Sacc., leaf spot.
Septoria gossypina Cke., leaf spot.
Verticillium sp. on dying seedlings, probably saprophytic.
Verticillium albo-atrum Reinke & Berth., wilt disease; now known from most cotton areas in Uganda south of Lakes Albert and Kioga, and increasing in incidence every year. Plants of all ages are attacked, shed their leaves, and many die out completely, though others may produce a second growth of small leaves and short branches from the base of the plant, but never recover sufficiently to produce a crop approaching normal. Bolls formed on the plants before the leaves are shed may open, but as a rule the contents are of very low grade and the fibres immature. The disease occurs on patches of soil, and slowly spreads out from these; it is distributed over the country in seed taken from diseased plants, a method impossible of control under present conditions. Efforts are being concentrated on raising cotton varieties more resistant to attack than those at present in general cultivation here. The fungus persists

in the soil for an indefinite number of years, and crop rotation does nothing to reduce attack on later cotton crops. The other hosts of the fungus known in Uganda are mentioned elsewhere in this list.

Alternaria sp., leaf spots; apparently three distinct forms of this genus have been recorded in Uganda, but none cause important diseases.

Fusarium acuminatum E. & Ev., boll rot; rare.

Fusarium moniliforme Sheld., ascus stage *Gibberella fujikuroi* (Saw.) Wr., boll rot; often a secondary invader after *B. malvacearum*; also causes a disease of seedlings simulating "sore shin", but the latter is much more common; a common saprophyte on dead and dying parts of cotton plants.

Fusarium vasinfectum Atk., and forms of *F. oxysporum* Schlecht., cotton wilt diseases; they may occur independently of *Verticillium albo-atrum*; rare cases of infection by *Fusarium* and *Verticillium* in the same plant have been found. Inoculations with local strains of *Fusarium* obtained from wilted plants have proved their pathogenicity; in the field it is impossible to distinguish between these various wilt diseases, and for purposes of raising resistant varieties they are all grouped together. During the 1936-37 season numerous specimens of cotton wilt have been examined from several districts of Uganda; the proportion of *Fusarium* wilt has proved much smaller than was expected from experience of the disease at Bukalasa Experiment Station in previous seasons. It now seems likely that *Verticillium* will prove the most important cause of wilt of cotton in Uganda.

Macrophomina phaseoli (Maubl.) Ashby, sterile stage *Rhizoctonia bataticola* (Taub.) Butl., causes a root disease, usually only on plants which have reached the flowering and bolling stages; these show a dying off and shedding of the foliage, and often the external symptoms closely resemble those of wilt diseases. In some cases dark streaks are found in the wood of the infected plants, rendering it even more difficult to distinguish this disease from wilt. Plants in advanced stages of *Rhizoctonia* disease show the minute black sclerotia of the fungus in the bark and wood of the roots and lower parts of the stem. Recent experience indicates that plants which have been subject to waterlogging of the soil are particularly liable to infection by *Rhizoctonia.*

Corticium vagum B. & C., sterile stage *Rhizoctonia solani* Kuhn, sore shin disease; cotton seedlings are attacked, the tissues of the hypocotyl at ground level are rapidly rotted, and the plants fall over and die. The conditions governing epidemic attacks are not well defined; such attacks have occurred in Uganda under very dry conditions as well as in periods of very wet, cool weather. Between these extremes cotton seedlings here appear to be more resistant, and as a rule the damage is not considered serious. Overcrowding of seedlings undoubtedly facilitates the infection and spread of the disease.

Sclerotium rolfsii Sacc., root disease, comparatively rare on cotton in Uganda, and usually limited to plants growing in swampy soil. The infected plants die out completely, and the white mycelium and yellow-brown sclerotia of the fungus are formed on the outside of the dead plant at ground level.

A number of fungi have been obtained from lint and from the inside of damaged bolls and seed:—

Aspergillus terreus Thom.
Aspergillus tamari Kita.
Aspergillus niger van Tiegh.
Chaetomium globosum Kze.
Chaetomium indicum Cda.
Diplodia theobromae Pat.
Diplodia gossypina Cke.
Monilia sitophila (Mont.) Sacc.

HIBISCUS CANNABINUS (Indigenous).

Nematospora gossypii Ashby & Nowell, in the seed of plants infested with *Dysdercus* (cotton stainers) during the close season for cotton.

Aecidium garckeanum P. Henn., rust.

HIBISCUS ESCULENTUS (Okra, Cultivated).

Nematospora gossypii Ashby & Nowell, in seed.

Aecidium erythrobasis B. & Br., rust.

Phyllosticta (hibiscina E. & Ev. ?), leaf spot.

Cercospora hibisci Tracy & Earle, leaf spot.

Fusarium vasinfectum Atk., wilt disease.
Verticillium albo-atrum Reinke & Berth., wilt disease.
Rhizoctonia solani Kuhn (*Corticium vagum* B. & C.), root disease, chiefly on young plants.
Macrophomina phaseoli (Maubl.) Ashby (*Rhizoctonia bataticola* (Taub.) Butl.), root disease.
Bacterium sp., rot of fruit.

HIBISCUS GOSSYPINUS (Indigenous).
Irenopsis coronata (Speg.) Stev., var. *triumfettae* Stev., on leaves.

HIBISCUS sp. (Indigenous).
Irenopsis coronata (Speg.) Stevens, var. *triumfettae* Stevens.
Irenopsis molleriana (Wint.) Stev., on leaves.
Irenopsis coronata (Speg.) Stev., var. *vanderystii* Beeli.
Ustulina zonata (Lev.) Sacc., base of stem, probably saprophytic.
Puccinia exilis var. *hibisci* Grove, rust.
Armillaria mellea (Vahl.) Fr., root rot.
Phomopsis malvacearum (West.) Died., prox., leaf spot.
Ascochyta gossypii Syd., prox., leaf spot.
Alternaria sp., leaf spot.
Cercospora sp., leaf spot.
Bacterium hibisci Nak. & Tak., black angular spot of *H. rosa-sinensis*.

SIDA sp. (Indigenous).
Chaetostigmella sidae Hansford,, parasitic on—
Asterina diplocarpa B. & C., black fungus on leaves.
Puccinia heterospora B. & Curt., rust.
Helminthosporium triumfettae P. Henn., prox., on leaves.

URENA LOBATA (Indigenous).
Irenopsis molleriana (Wint.) Stevens, on leaves.

EUPHORBIACEAE.

ACALYPHA sp. (Indigenous).
Irenina acalyphae Hansford, on leaves.
Asterina tenuis Wint., on leaves.
Calonectria guarapiensis Speg., on stem.
Melampsora acalyphae Petch, rust.
Meliola chandleri Hansford, on leaves.

ALCHORNEA sp. (Indigenous).
Irenina entebbeensis Hansford, on leaves; parasitized by—
Perisporium paullimiae Stev.
Asterina alchorneae Hansford, on leaves.
Micropeltis sp., leaf fungus.
Uredo sp., indet., rust.

ANTIDESMA sp. (Indigenous).
Puccinia aequalis P. Henn., rust.
Pestalozzia sp., leaf spot.
Aulographium sp., on leaves; parasitized by *Helminthosporium* sp.

ARGOMUELLERA sp. (Indigenous).
Uredo sp., indet., rust; parasitized by *Cephalosporium* sp.

BRIDELIA sp. (Indigenous).
Limacinia transvaalensis Doidge, on leaves.
Asterina sp., on leaves.

CLUYTIA sp. (Indigenous).
Uromyces cluytiae, var. *minor* Wakef., rust.

CODIAEUM sp. (Cult. Garden Plant).
Rhizoctonia lamellifera Small, on roots, causing dieback and death.

CROTON sp. (Indigenous).
Parodiella kampalensis Hansford, on leaves.

EUPHORBIA sp.
Peronospora valesiaca Gaumann, downy mildew of *E. scordifolia*.
Oidium sp. (? *Microsphaeria euphorbiae* (Pk.) B. & Curt.), mildew.
Meliola ugandense Hansford & Stevens.
Uromyces proeminens (DC.) Lev., rust of *E. inaequilatera*.
Melampsora sp., rust.
Helminthosporium euphorbiae Hansford, leaf spot.
Alternaria sp., leaf spot.
Cercospora euphorbiaecola Atk., leaf spot.
Cercospora sp., leaf spot of *E. pulcherrima*.

HEVEA BRASILIENSIS (Rubber).
Oidium heveae Steinm., mildew and leaf-fall, found all over Uganda; sometimes it causes severe leaf shedding, but its effect on yield is not known in Uganda. On some estates the setting of seed is much reduced. No attempts have been made in Uganda to control the disease, and it is doubtful whether such would prove profitable, as the disease is not limited to definite seasons here.
Eutypella heveae Yates, on dead branches.
Helicobasidium longisporum Wakef., on roots and base of tree; rare; pathogenicity doubtful.

Armillaria mellea (Vahl.) Fr., root rot, not common on rubber in Uganda, except under very wet soil conditions.

Fomes lamaoensis Murr., brown root disease, not common on living trees, but a common saprophyte on dead stumps and roots of rubber trees cleared out when developing the new Experiment Station at Kawanda.

Sphaeronema fimbriatum (E. & H.) Sacc., mouldy rot of the tapped surface; only important in very wet weather, and controlled by cessation of tapping and treatment of the bark with disinfectants.

Phyllosticta heveae, Zimm., leaf spot.

Phoma heveae Petch, on dying branches.

Placophomopsis heveae Grove, on twigs.

Gloeosporium albo-rubrum Petch, on leaves and fruit.

Pestalozzia palmarum Cooke, on dead and dying leaves and twigs.

Tubercularia versicolor Sacc., on healing tapped surface.

Pleonectria pseudotrichia (Schw.) Wr., conidial stage *Stilbella cinnabarinum* Mont., on dead twigs and bark.

Rhizoctonia lamellifera Small, on roots, causing slow death and extending to main roots and base of tree; the attack is accompanied by slow dieback of the crown, and in the roots often by other fungi such as *Fomes* sp. and *Armillaria mellea*. The trees have considerable powers of recovery from early stages of this disease, which is not important in Uganda.

MACARANGA sp. (Indigenous).

Irenina entebbeensis Hansford & Stevens, on leaves.

Scolecopeltis sp., on leaves.

Asterina alchorneae Hansford, on leaves.

Skierkia macarangae Hansford, rust.

MANIHOT UTILISSIMA (Cassava).

Armillaria mellea (Vahl.) Fr., rot of roots and tubers, not common.

Verticillium albo-atrum Reinke & Berth., wilt disease, only recently discovered at Bukalasa; further distribution unknown; the fungus is transferable to cotton, on which it causes similar symptoms, and is able to remain in the soil indefinitely; crop rotation is thus of little benefit in control of this disease. Varietal reaction to the disease has not yet been worked out.

Fusarium oxysporum Schlecht., f., also associated with wilt disease; hitherto the forms isolated from wilted cassava have failed to reproduce the disease on inoculation through the soil.

Cercospora henningsii Allesch., common leaf spot of cassava; considerable differences in varietal susceptibility have been recorded; leaf-shedding is caused on very susceptible varieties.

Bacterium cassavae Hansford, angular leaf spot and stem disease; discovered at Bukalasa, and further distribution not worked out. Little damage occurs on varieties in general cultivation.

PHYLLANTHUS sp.

Aecidium phyllanthi P. Henn., rust.

RICINUS COMMUNIS (Castor Oil).

Melampsora ricini Pass., rust.

Alternaria ricini (Yoshii) Hansford, leaf spot; the fungus corresponds to *Macrosporium ricini* Yoshii, but belongs to *Alternaria*, the spores often being in chains of two.

Cercospora canescens E. & M., leaf spot, and common on dying tissues.

Cercosporella ricinella (Sacc. & Berl.) Speg., leaf spot.

SAPIUM MANNIANUM (Indigenous).

Irenina entebbeensis Hansford & Stevens, on leaves.

Cercospora sapiicola Speg., leaf spot.

Exosporium lateritium Syd., reddish-brown growths on leaves, often parasitized.

TRAGIA sp. (Indigenous).

Puccinia tragiae Cooke, rust.

HOST indet.

Aulographium sp.

Asterina sp.

ROSACEAE.

ERIOBOTRYA JAPONICA (Loquat).

Ascochyta eriobotryae Vogl., leaf spot.

PRUNUS PERSICA (Peach).

Puccinia pruni-spinosae Pers., rust.

ROSA sp. (Cultivated Roses).

Sphaerotheca humuli (DC.) Burr., in its *Oidium* stage, causes a common mildew of roses, but does little damage on the whole in Uganda.

Armillaria mellea (Vahl.) Fr., root rot, uncommon on this host.

Coniothyrium fuckelii Sacc., rose canker, uncommon in Uganda.
Diplocarpon rosae Wolf, black spot disease, on leaves, common all over Uganda.
Cercospora rosicola Pass., leaf spot.
Stagonospora rosae Brun., on dying twigs and stems.
Rhizoctonia bataticola (Ttaub.) Butl., the sterile stage of *Macrophomina phaseoli* (Maubl.) Ashby, root disease; usually very slow, but affected plants are often attacked by termites.
Bacterium tumefaciens EFS., crown gall, not common.
The following have also been recorded in Uganda from roses, but are probably only saprophytic on dead or dying tissues: —
Pyrenochaeta sp.,
Phoma sp.,
Phomopsis sp.,
Vermicularia sp.

RUBUS sp. (Indigenous).
Irene calostroma (Des.) v. Hohnel, on leaves.
Chaetostigmella sp., on leaves.
Glomerella cingulata (Ston.) Spaul. and Schrenk, ripe rot of fruit.
Hamaspora longissima (Thun.) Koern., rust.
Cercospora heteromalla Syd., leaf spot.

CESALPINIACEAE.

CASSIA sp. (Native and Introduced).
Ravenelia sp., indet., rust.
Aecidium torae P. Henn., rust on *C. tora.*
Uredo sp., possibly of *Ravenelia.*
Ganoderma australe (Fr.) Pat., on dying trees, probably weakly parasitic.
Heterosporium sp., leaf spot.
? *Cercospora personata* (B. & C.) E. & Ev., on leaves; this record probably refers to *Cyptocoryneum* sp., on leaves.
Isariopsis cassiae Hansford, leaf spot.
Microstoma albizziae Syd., on leaves, causing shedding.
Rhizoctonia lamellifera Small, root disease; uncommon.

CESALPINIA sp. (Native).
Stilbella fasciculata B. & Br., on twigs and stems.

PIPTADENIA AFRICANA (Indigenous).
Nectria ochro-leuca (Schw.) Berk., on dead branch.

MIMOSACEAE.

ACACIA sp. (Indigenous).
Ravenelia escharoides Syd., rust.
Rhizoctonia lamellifera Small, root disease; uncommon.

ALBIZZIA sp. (Native and Introduced).
Meliola bicornis Wint., on leaves and young stems.
Dothidea albizziae Hansford, on leaves.
Phragmocauma viventis (Cke.) Theiss. and Syd., on leaves.
Eutypella corynestoma (B. & Rav.) Sacc., dead branches.
Ravenelia minima Cooke, on *A. brownei,* rust.
Sphaerophragmium sp., on *A. coriaria,* rust.
Polyporus fyffei Wakef., on base of dying tree.
Phyllosticta divergens Sacc.
Phyllosticta ramicola Petch, on dead twigs.
Cercospora sp., leaf spot.
Cryptocoryneum sp., leaf spot.
Microstoma albizziae Syd., on leaves, causing defoliation.
Rhizoctonia lamellifera Small, root disease of *A. moluccana.*

(To be continued)